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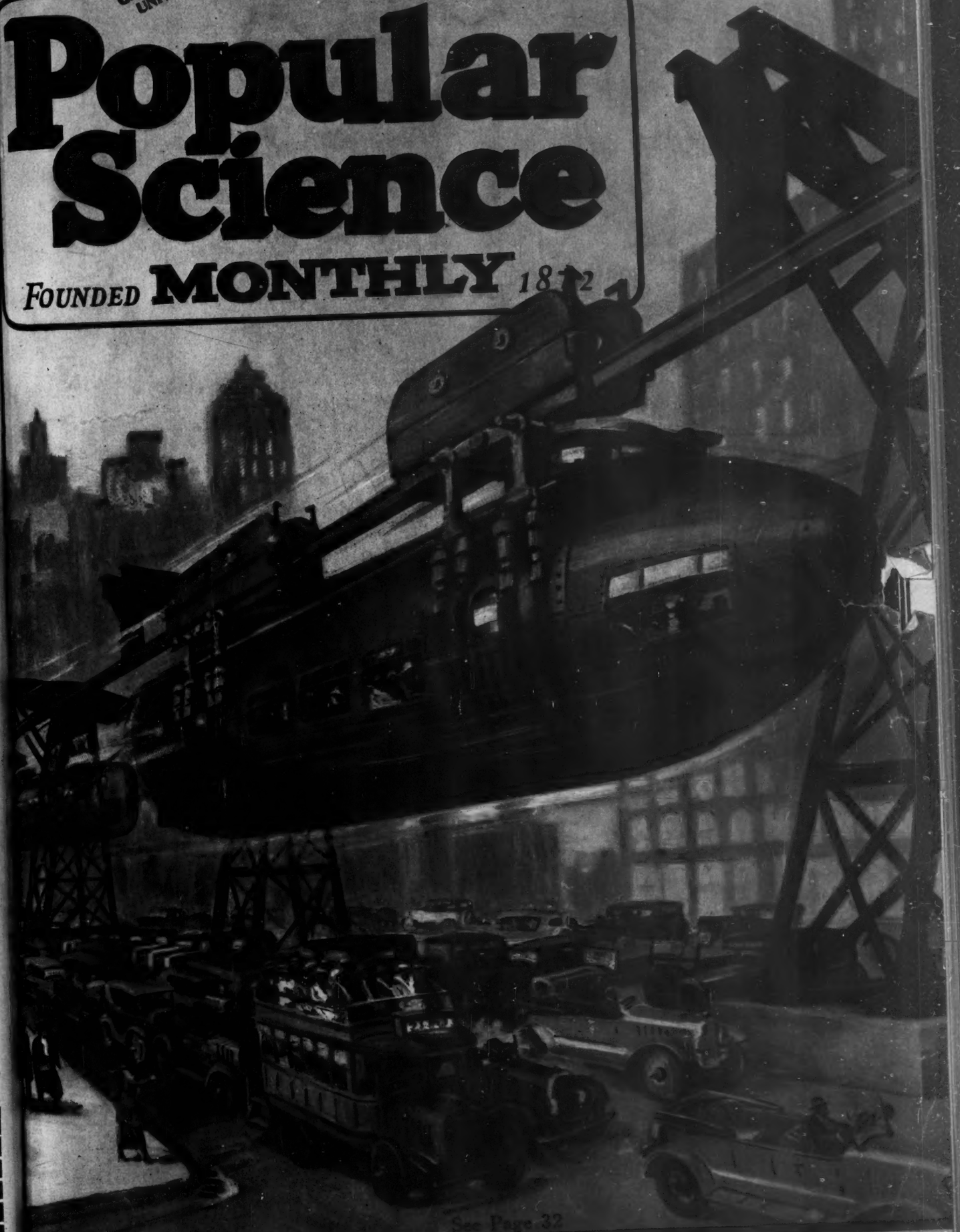

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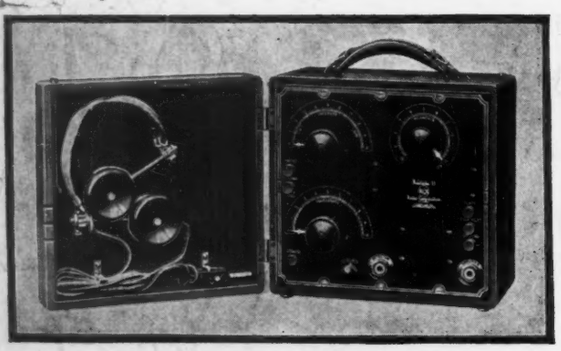

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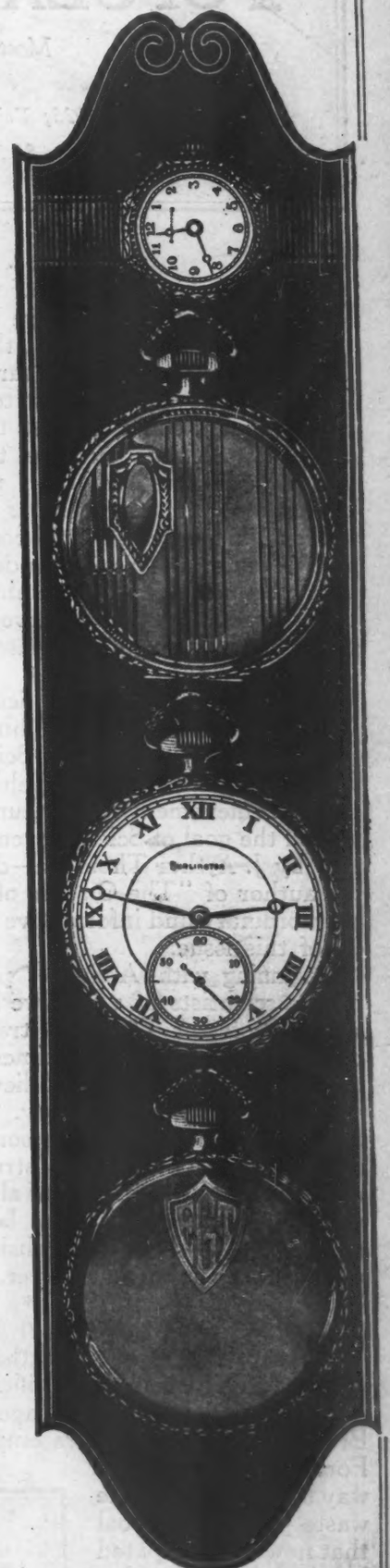

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POPULAR SCIENCE MONTHLY

Most Wonderfully Illustrated Magazine in the World

NOVEMBER, 1923; Vol. 103, No. 5
25 cents a Copy; $2.50 a Year

Published in New York City at
225 West Thirty-ninth Street

WITH the beginning of the twentieth century dawned the Age of Science for the average man. Before that time he looked upon Science as something far removed from his sphere of life—a dry, uninteresting, probably useless study, suited only to the bookworm and the pedant. Little by little, though, in the last two decades, he has been realizing the true meaning of Science. He has seen that Science holds an intimate, personal connection with him and the affairs of his workaday world. He has learned that Science is eminently useful, entirely practical; that it serves his comfort, relieves his distress, and increases his happiness.

* * *

UTILITY, practical application, the satisfying of some existing human need—these ever have been the aims of Science since earliest times, the driving power behind each new scientific achievement. How human necessity furnished the goal of Science even 2000 years ago is told by J. Arthur Thomson—distinguished British author of "The Outline of Science"—in an extraordinary and informative interview on page 29 of this issue.

Beginning with Aristotle, probably the first of the scientists of whom we have exact knowledge, Professor Thomson traces the advance of Science to our own times, and makes up a list of those whom he believes to be the 10 greatest scientists of history. Even those who may not agree with Professor Thomson in his selections are bound to be struck by a remarkable similarity in the lives of all the great men of whom he tells—all of them labored unselfishly and long that their accomplishments in Science might make the world a better, happier place.

* * *

COMING from the days of Aristotle and Galileo to the present day, the wonders of Science still find their exemplification in fields of practical usefulness. On page 34 Raymond J. Brown tells how engineers employed by Henry Ford have devised a way to extract from the waste products of coal that now are dissipated in the air as smoke, enough motor fuel to run every automobile in the United States. Illuminating gas, motor lubricants, valuable chemical products are other things which Ford engineers have found may be taken from coal without disturbing its industrial utility.

* * *

NOT only for economic purposes, but in the protection of our lives and property, has the practical application of Science lately been found of value, according to Richard E. Enright, Police Commissioner of New York City, in a thrilling article on the scientific detection of crime, beginning on page 42. Describing how Science helped solve recent sensational crimes, Commissioner Enright declares that the modern police officer is surpassing the imagined feats of Sherlock Holmes every day. He predicts that through Science crime will some day be made to disappear from the earth.

* * *

THE Science of Medicine is of its very nature practical, but even this is steadily progressing into wider spheres of usefulness. No more remarkable example of recent practical development in medicine is furnished than the refinement of the once dangerous operation of blood transfusion to a point where it may be performed without danger in the treatment of no less than 28 specific illnesses. The story of this achievement is told on page 46.

* * *

IN THE forefront among Americans who have seen fit to apply modern Science closely to their own lives stands Samuel M. Vauclain, president of the Baldwin Locomotive Works, who has been sick only once in his 67 years. On page 38, Mr. Vauclain tells how to insure perfect health. He has signed a 10-year contract with a physician to keep him well; and he offers a modification of his plan that may be followed by any individual, family, or community.

* * *

OF THE many other fascinating articles in this issue—about 200 in all—each deals with a distinct field of scientific progress; yet all are alike in revealing vividly how science enters into our everyday lives—in our homes, shops, and offices—to bring us comfort, security, and happiness.

POPULAR SCIENCE MONTHLY

Issued monthly. *Single copy, 25 cents. Yearly subscription to United States, its possessions, and Canada, $2.50; foreign countries, $3.*

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H. J. Fisher, *President*; R. C. Wilson, *Vice-President*
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Men of the Hour in Science

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A TRIO OF MASTER MINDS in the realm of electricity. From left to right: Dr. Irving Langmuir; Dr. W. R. Whitney; Dr. W. D. Coolidge. Langmuir is the inventor of the gas-filled, or nitrogen electric, lamp, as well as the 20-kilowatt vacuum tube—the tube that was first used at Rocky Point, L. I., for successful transatlantic radio communication. Whitney, who is director of the Research Laboratory of the General Electric Company, is the holder of many electrical patents. One of his outstanding achievements was the perfection of a submarine detector used during the war. Coolidge recently perfected a 200,000-volt X-ray apparatus, one of the largest made, used as a radium substitute in the treatment of cancer.

DR. EDWARD FRANCIS, of the United States Public Health Service (below), after exhaustive investigations since 1919, has discovered the sources of "rabbit fever." The malady presents symptoms similar to those of typhoid or septic infection, and lasts from three to six weeks. Doctor Francis has found that it is transmitted to man from rodents by the bite of an infected blood-sucking insect, or by the handling of infected rodents.

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DR. W. W. COBLENTZ, of the United States Bureau of Standards, announces as the result of laboratory experiments that aluminum paint, if applied to the under side of an automobile top, tent, or awning, will reduce greatly the amount of heat absorbed by the sun and re-radiated on the under side. He has found, too, that the heat radiated from an aluminum painted radiator is measurably less than that emitted by a radiator painted with a non-metallic paint.

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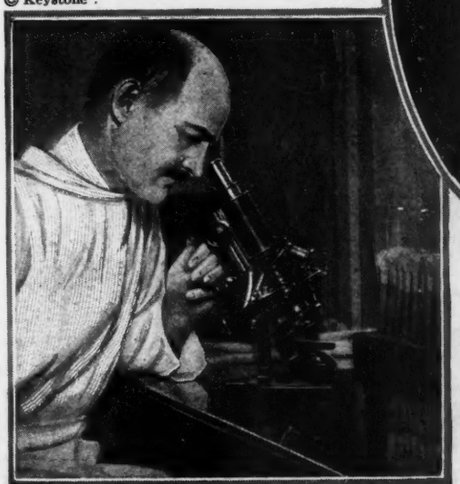
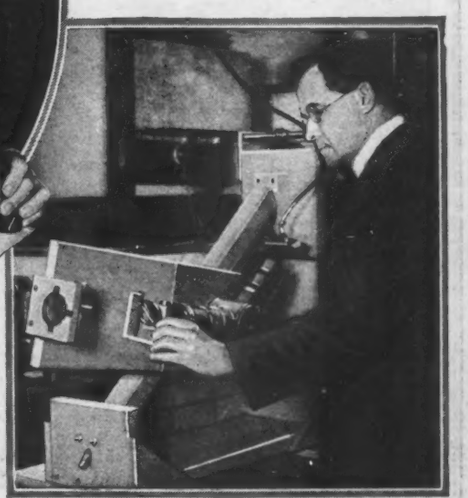
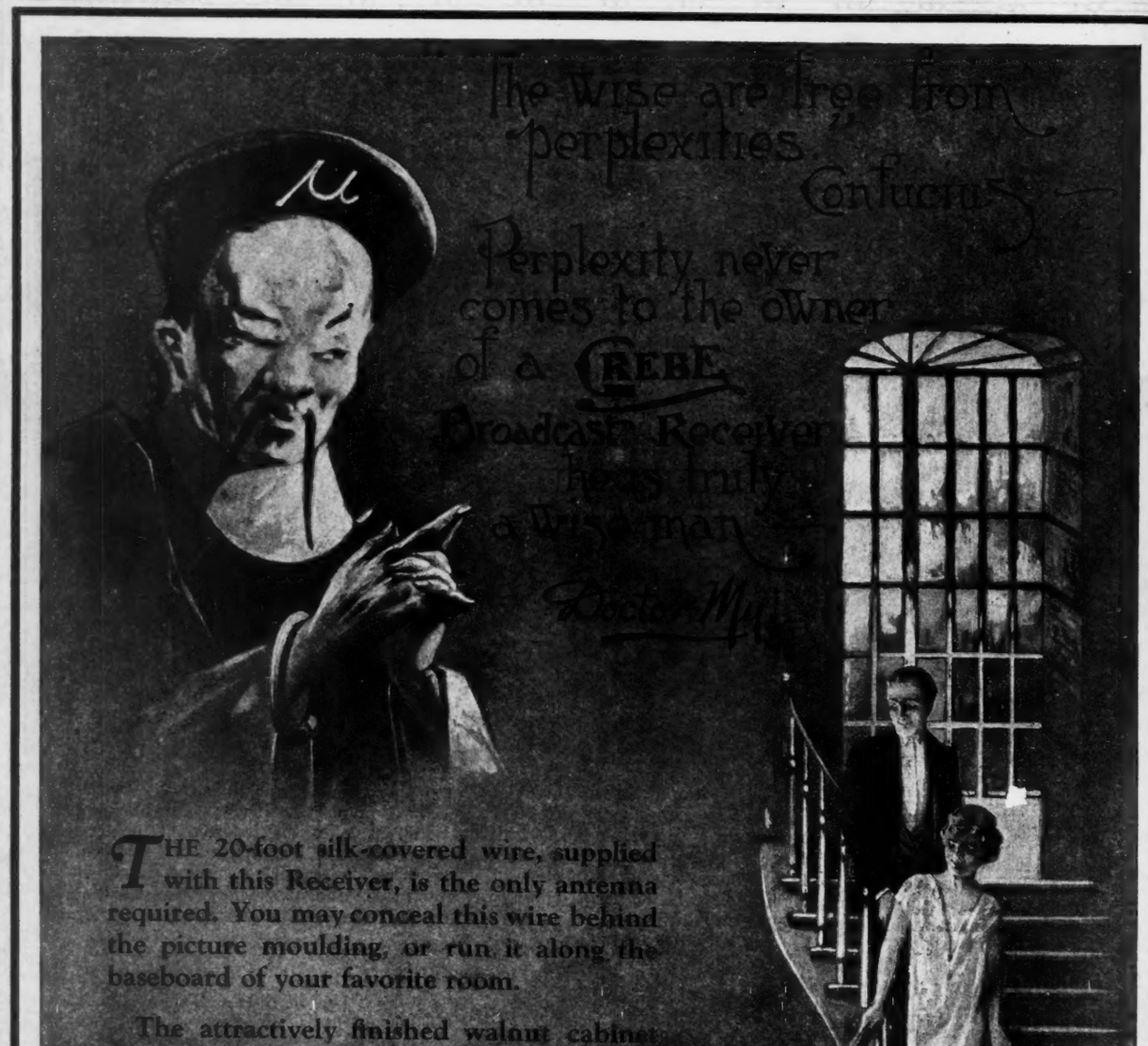


Dr. Edward Francis in his laboratory

DR. WILLIAM MANN, of the United States Bureau of Entomology, has just returned from Mexico, bringing new facts about the Mexican fruit fly, one of the pests that cause this country more than a billion dollars damage each year.



Dr. W. W. Coblentz testing heat radiation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law than the law of gravitation (Einstein's theory), but even this does not mar the

POPULAR SCIENCE MONTHLY
SUMNER N. BLOSSOM, Editor
November, 1923

The World's 10 Greatest Scientists; What They Have Done for You

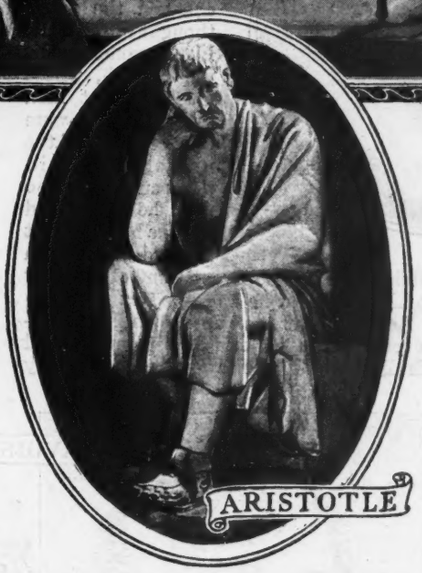
"What I mean by a great scientist is one who in his time has made the world new, one who has opened the gates and let in a flood of knowledge that changed everything."

Such is the rigid standard by which J. Arthur Thomson, Regius Professor of Natural History in the University of Aberdeen, Scotland, and author of "The Outline of Science," answers here the question recently put to him by POPULAR SCIENCE MONTHLY: "Who are the world's 10 greatest scientists?"

Here are his selections, with his reasons for placing them on the list of the greatest

As told to G. B. Seybold

By J. Arthur Thomson



WHO are the 10 greatest scientists of history?

The question reminds me of the great philosopher who, having spent a lifetime working out a system of thought, was approached by a young woman and airily asked, "Will you please give me the gist of your philosophy in a word or two?"

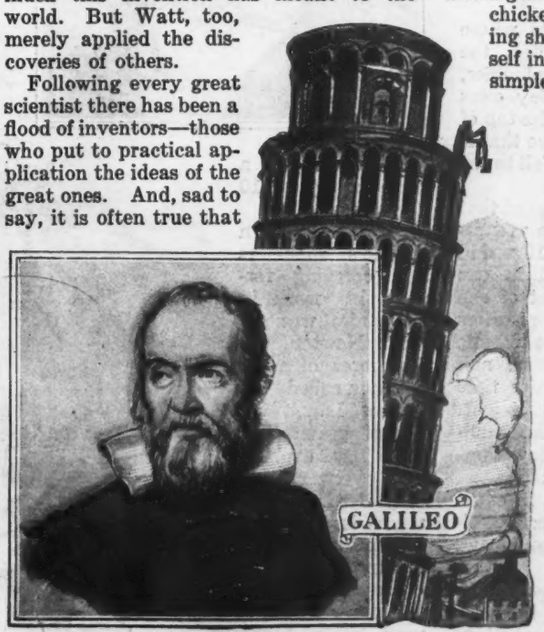
To select from the whole field of science and from all the pages of history 10 men who stand out clearly above the thousands, and to show why they are the towering peaks, is not a simple task. Much depends upon what one means by the word "great" in connection with science. Often we judge from those results that are the most obvious. A great scientist? Instantly there darts to the mind the thought of Edison. Here is a man who has done great things, who is working in his laboratory night and day to bring forth new marvels.

But Edison could not be included in a list of the 10 greatest scientists in the world's history. For Edison stands upon the shoulders of others. He is a practical man making use of the underlying principles discovered by the great scientists.

Back of Edison, for example, is a man whom I am tempted to include in my list of 10 scientists. He is Willard Gibbs, who made many of the discoveries upon which Edison's work is based. But who is Willard Gibbs? Perhaps one of 50 persons, even among his own countrymen, recognizes the name of this great American.

The position of James Watt in history is similar to that of Edison. Every schoolboy knows that Watt invented the condensing steam-engine and realizes how much this invention has meant to the world. But Watt, too, merely applied the discoveries of others.

Following every great scientist there has been a flood of inventors—those who put to practical application the ideas of the great ones. And, sad to say, it is often true that these inventors, because their work is more obvious, are much better known than the fathers of science.



What I mean by a great scientist is one who in his time has *made the world new*, one who has opened the gates and let in a flood of knowledge that changed everything. The greatest scientists are those who discovered new principles, those who laid the foundation stones of science.

The great foundation-layer and one whom I put first on my list of 10 is Aristotle. In Aristotle's time, with the exception of mathematics (for even then, more than 2000 years ago, mathematics was a high science), everything that we now consider science was in a muddled state of ignorance and superstition. Stories served for scientific explanations.

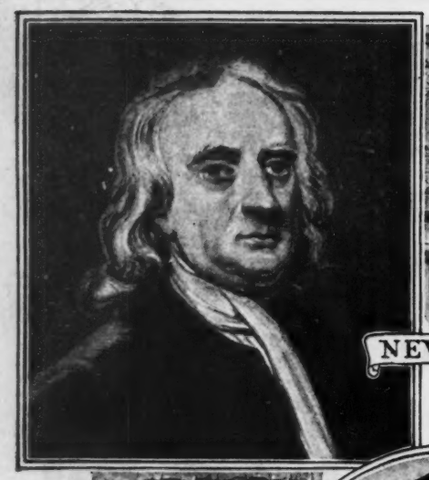
But Aristotle's was a great mind, and he was dissatisfied with myths and fancies concerning the things about him. "I want to know," he declared. And he searched for knowledge until he found it.

He had listened to many long discussions and arguments about the process whereby a chicken came forth from an imprisoning shell. But Aristotle satisfied himself in a way that today we think very simple. He broke open an eggshell every day and observed just how far the little chick had developed. When Aristotle thus discovered animal development, he marked a new epoch in the history of mankind.

Aristotle laid the foundations of comparative anatomy, for he dissected many animals and gained a very thorough knowledge of their structure. He did not believe, as some who came after him did, that bats were birds or that whales were fishes. He understood that whales and bats both were mammals.

Aristotle wrote a wonderful book on animals which may be studied with profit even today. He had intimate knowledge of bird and beast and plant. He observed carefully every detail of their outward appearance

changed the methods of all physicians,



NEWTON

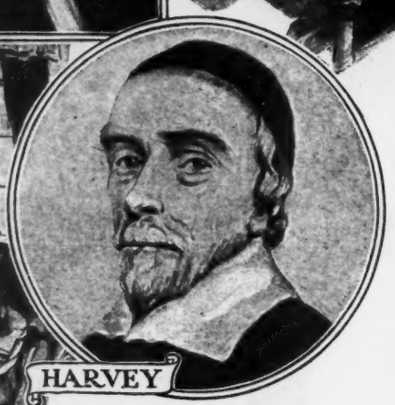
law than the law of gravitation (Einstein's theory), but even this does not mar the perfection of Newton's discovery, for the new law contradicts in no way the truth of the law of gravitation. Rather, it embraces it.

Newton opened a wide gate when he found this key that was shown to fit all the locks of astronomical movements, such as the revolution of the planets and their satellites, and the coming and going of the comets in immensely elongated ellipses. Then, too, he showed how to calculate the mass of the sun in terms of the earth, how to find the exact shape of the earth, how to explain the tides, and much more besides. As Pope said:

> Nature and Nature's laws lay hid in night.
> God said, Let Newton be, and all was light.

Newton, the discoverer of the law of almost universal application, has a firm position among the great.

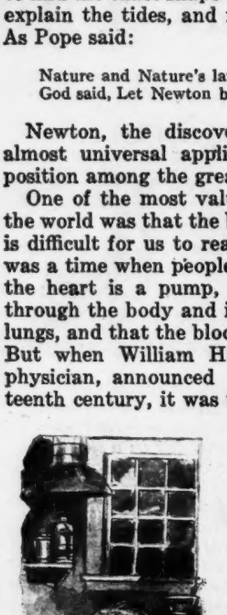
One of the most valuable discoveries in the world was that the blood circulates. It is difficult for us to realize now that there was a time when people did not know that the heart is a pump, forcing pure blood through the body and impure blood to the lungs, and that the blood moves in a circle. But when William Harvey, the English physician, announced this in the seventeenth century, it was the sensation of the day.

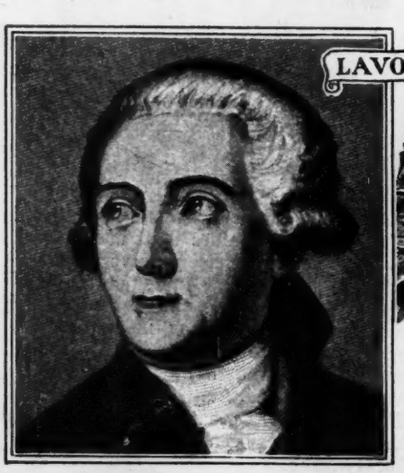


HARVEY

Others before his time had approached this important discovery. They had made guesses about the movement of the blood; but Harvey was the first actually to demonstrate the circulation and explain the mechanics of the flow. Instead of guessing, he watched through a lens the movement of an animal's heart. Instead of theorizing, he observed blood flowing in the web of a frog's foot. He used the true scientific method. He made experiments. That was why he was great, even as Galileo was great. He got upon a platform and actually *demonstrated* how the blood circulates.

Besides this discovery, which ultimately entitles him to a place among our 10 greatest scientists.





LAVOISIER

HELMHOLTZ

and their habits, then dissected them to see what was within. He was interested not only in the architecture of animals, but in how they lived, what they ate, how they cared for their young, how they struggled for existence. For hours at a time he carefully observed the movements of starfish and seaurchins at the seashore.

His intense curiosity, satisfied by patient and careful observation, enabled him to classify the sciences and point out the way that others after him could follow. Scientists today are still following lines of thought marked out by this great Greek pioneer.

Another of the early scientists whose achievements stand out is Galileo, the father of mechanics. Every shipbuilder, bridge-builder, and mechanic today owes much to Galileo, who climbed to the top of the Leaning Tower of Pisa to prove that it took no longer for a light book to fall to the ground than a heavy iron weight.

In Galileo's time, every one believed that bodies fell to the ground in time proportional to their weight—that is, a 10-pound weight would reach the ground in one tenth the time taken by a weight of one pound. While students and professors ridiculed him, Galileo climbed the historic Leaning Tower in his home town and dropped from the ledge at the same time a ten-pound and a one-pound weight. They hit the ground together. Then Galileo announced his revolutionary law that, making allowances for air resistance, all bodies fall from the same height in equal time. Afterward he made further experiments to demonstrate his now famous Laws of Motion.

Galileo was a maker of telescopes. With his instruments he studied the heavens, amazing the whole world. How marvelous was the announcement that the earth revolved about the sun instead of the sun revolving about the earth! It changed the whole thought of the time. Little wonder that the Church, whose teaching that man and the world were the center of the universe, should persecute Galileo until he was forced to take back all that he had said, even while he protested fervently and obstinately in his heart that he knew he was right.

Astronomy rests upon Galileo's discoveries. His work as an astronomer and his discovery of the laws of motion surely

Standing upon Galileo's shoulders and carrying forward his work in mechanics was Sir Isaac Newton, the discoverer of what has been called "the Perfect Law," the law of gravitation. This law explains how every particle of matter in the universe is changing its motion with reference to every other particle. We think now that there may be a bigger

Torpedo Cars to Speed above

changed the methods of all physicians, Harvey did much in combatting the idea—foolish it seems now—of spontaneous generation. People believed that a fly, for example, could spring spontaneously from a piece of meat and that a worm could develop from a horse hair. But Harvey, from careful study of embryos, said: "Every living creature comes from a living creature." Harvey unravelled the tangled thoughts of his day about the human body and gave medicine a great push forward. With little hesitation I put him fourth on the list.

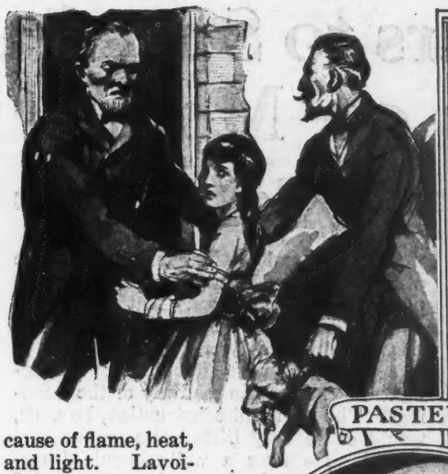
Antoine Laurent Lavoisier was a French chemist who lived in Paris during the time of the French Revolution. Crying: "We have no need of scientists!" an angry mob condemned him to be guillotined. His claim to greatness lies in his contribution of the idea of the conservation of matter.

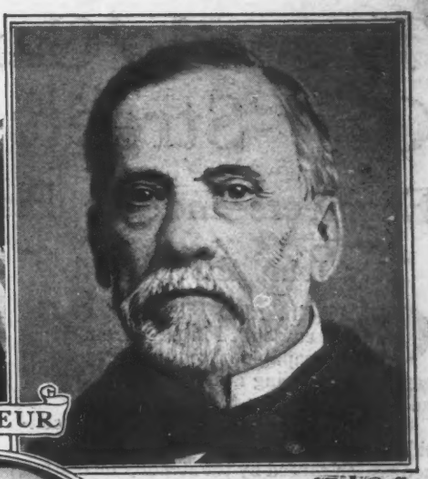
Before Lavoisier there were no chemists, unless you regard as chemists the many alchemists who stood over pots striving to change various elements into gold.

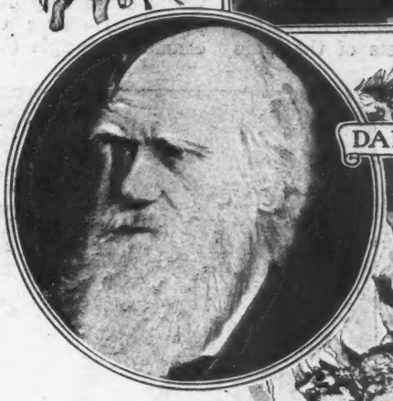
Lavoisier stated the principle that when one starts out with a substance of a given weight, and after putting it through different processes, gets something different—gases, solids, or liquids—all of these added together in the end should give the same total as the original weight. This is true, he said, if the substance has been confined so that nothing has had a chance to escape.

Since then, the balance has become one of the most important devices in the chemical laboratory. Now, when we find that a substance weighs less after it has passed through a certain process, we conclude that something has escaped. What was it? Then we find out what escaped and learn, perhaps, that what formerly was lost and wasted can serve some useful purpose in business or manufacture.

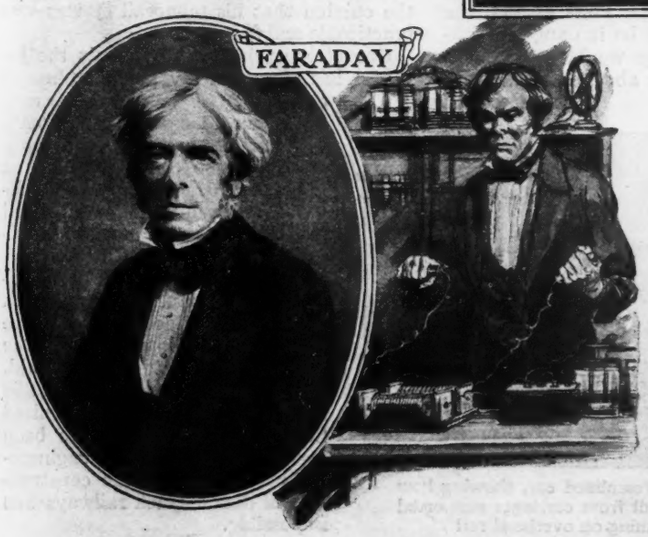
Lavoisier was the first man to understand and explain it correctly. The teaching of the day was that there was in inflammable substances a certain material of fire called "phlogiston" which, when released, was the cause of flame, heat, and light. Lavoisier denied the existence of this mysterious material and overthrew the superstition by demonstrating that the presence of oxygen was the factor that brought about combustion. He showed that rusting of iron, burning of coal, and the explosion of dynamite all were the results of the same process of oxidation carried out at different speeds.







Every worker in munitions, every worker with dyes, every person whose work is based on chemistry is indebted especially to Lavoisier, who established the foundations of modern chemistry.



Sometimes it is easier to pick out the great principles that have meant most to the world than it is to fit names to them. I find that to be the case now. For surely, beside the principle of the Conservation of Matter there should be placed the principle of the Conservation of Energy. But who is the one man who stands above his fellows here? There are Joule and Mayer and Kelvin, each with special claims for greatness; but I am inclined to single out Helmholtz.

Even as Lavoisier declared that no matter could be lost, Helmholtz said that no energy could be lost. "There is no power lost or created," he said; "but one kind of power can be changed into another."

All about us we see examples of one form of energy being changed into another. We see the great Niagara—the motion of the falling water being changed into electricity. We see coal being turned into steam. We see horsepower being changed into heat. If we want to go farther back than that, we may ask for the source of horsepower and learn that the horse gets its energy from the food it eats.

In a Swiss valley there is a waterfall at the foot of which is a pile of fertilizer. Man has learned how to harness the waterfall and take nitrogen from the air, making it take the form of fertilizers for the soil. This single discovery may save the world some day. Should there be a famine, we might get fertilizer for our crops on a large scale from the air, or perhaps some day we may convert the nitrogen directly into foodstuffs. And back of all this is Helmholtz, who first had the clearness of vision to see that one kind of power could be converted into another without loss.

Michael Faraday has a right to be placed among the great as the representative of all the modern discoveries in electricity. From his researches in chemistry, electricity, and magnetism have resulted the electric telegraph and telephone and thousands of applications of electricity and electromagnetism. Up to the time of this English blacksmith's son, electricity was a

(*Continued on page 138*)

"Flightless" Flights Test Aviators

Torpedo Cars to Speed above City Streets on Monorail

Engineers Indorse Plan to Relieve Traffic

Our artist's conception of the monorailway elevated above streets; based upon the working plans of the inventor

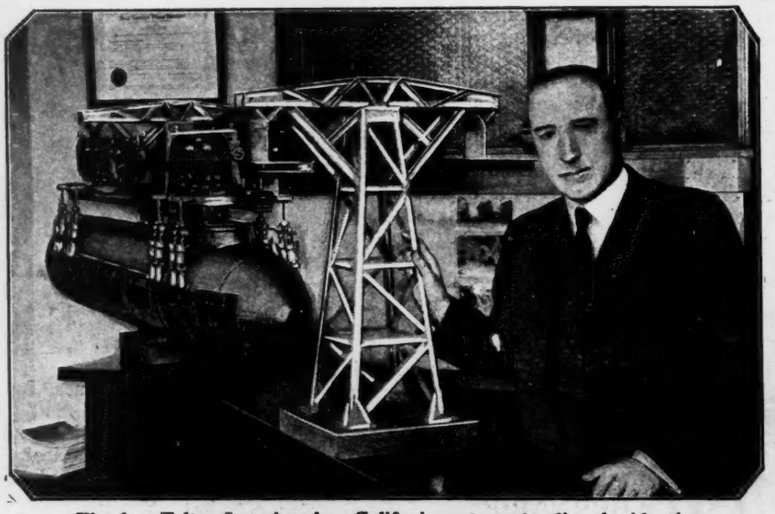
By John Anson Ford

CIGAR-SHAPED steel cars, 60 feet long, suspended in pairs from single rails, capable of seating 100 passengers, and traveling at 100 miles an hour if necessary far above the streets—

That is the suggestion now being considered seriously for solving the problem of congestion caused by the steadily increasing motor traffic in the streets of the large cities of the United States.

It is not the fantasy of an impractical dreamer, nor even a far-sighted scientist's vision of the streetcar of the future, but a practical plan that has been worked out to the last detail. It has received the approval of prominent engineers in many parts of the country and its inventor, Fletcher Felts, declares that it could be applied immediately in Los Angeles, Calif., the city for which it was designed.

Los Angeles has an automobile to every 4½ persons of its population. It was to permit the thousands of autos to move through the streets with convenience and safety as well as to provide safer and faster transportation for those who use the streetcars that Mr. Felts planned his monorail system. Although designed specifically to meet the traffic problems of Los Angeles, the system might be applied equally well, the inventor says, in solving traffic problems in other large cities, particularly in Cleveland, Ohio; Detroit, Mich.; Kansas City, Mo.; New Orleans, La.; Toronto, Canada; St. Louis, Mo.; Jersey City, N. J.; Pittsburgh, Pa.; Cincinnati, Ohio; and San Francisco, Calif. Monorail streetcars even now are being operated in Germany. The Felts system resembles these only in the fact that it provides cars hung from a single rail.

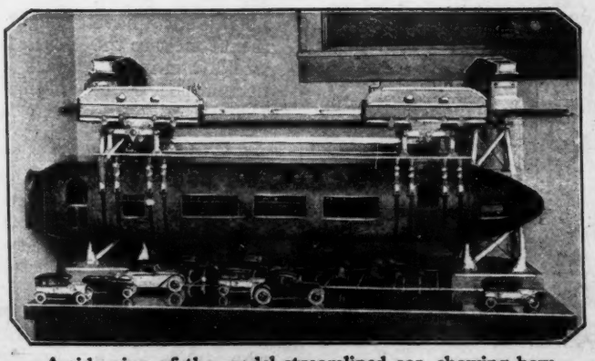


Fletcher Felts, Los Angeles, Calif., inventor, standing beside the model of his monorail structure and car. Note the steel towers with arms from which are suspended the two monorails, one on each side

Mr. Felts' plans are for two monorail tracks, permitting cars to pass in both directions above the street. Both tracks would be supported by a series of angle-iron steel towers, eight feet square at the base, 60 feet apart and of heights varying according to the exigencies of construction. The towers would extend in a row down the center of the street and the tracks would be suspended from steel arms at each side. The intervals between towers would be reserved for the parking of automobiles. This, it is estimated, would permit about 60 cars to be parked in a 600-foot city block, instead of 40 or so, which is the limit for a block of that length under the present curb parking system.

Stairways and platforms similar to those of the ordinary elevated railway would be provided for passengers. But unlike elevated railways, Mr. Felts says, his monorail, requiring only a small amount of structural work, would not obstruct the sunlight either from the roadway or the buildings. The monorail construction, he adds, would cause very little noise as the cars passed. He cites a well-recognized mechanical principle that a load suspended below a rail causes less vibration than one resting on the rail, producing less noise and bringing greater comfort in riding. This effect would be augmented by the fact that the cars would be suspended by means of patented air-cushion springs.

A cross section of the car would resemble an inverted *U*. The cigar shape, of course, is for the purpose of lessening wind resistance. The carriage from which the cars would hang would almost completely encircle the single I-beam on which the wheels would rest. Should an accident remove any of the wheels, Mr. Felts asserts, the passengers would not be in danger of falling, since the carriage would continue to hold the car in place above the roadway.



A side view of the model streamlined car, showing how it is suspended below the rail from carriages supported on inclosed wheels running on overhead rail

The operator would be stationed in a conning tower near the front of the car. Controls would run back over his head to the motor, a separate power unit following the carriage as an idler and receiving current from a "third rail," which in this construction, of course, would be a second rail.

Where tracks intersected at crossings, a gap of three feet four inches would be cut in each. Auxiliary rollers fitted to the carriages would support the cars until the carriage itself crossed the gap. These rollers would be lifted, except when it was necessary to use them at crossings. Idlers would be provided on both sides of the I-beam track to prevent side swing, while rolling idlers fitting snugly beneath the beam would eliminate galloping and rocking.

The pivot connecting the car with the carriage would be connected rigidly with a turntable and would ride on ball bearings.

Mr. Felts' plans are being carefully considered by traction authorities in Los Angeles. Before submitting his drawings and specifications to the city, he permitted many engineers of standing to examine them. All of them, he asserts, expressed the opinion that his monorail system was practicable and feasible.

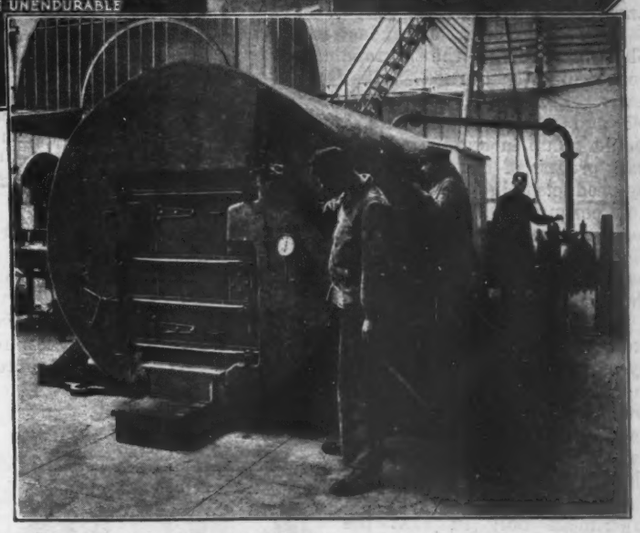
One of the principal arguments the inventor has offered in favor of his plans is economy. A subway, he contends, would cost about $7,000,000 a mile to build, while a monorail might be constructed for as little as $100,000 a mile. Additional safety and increased speed in transportation are other advantages he has mentioned.

Plans for an interurban monorail air line connecting Paris with eight near-by places recently have been reported from France. The cars of this system, it is said, would be capable of traveling 250 miles an hour. In the United States monorail lines have been used on a small scale in engineering projects where the construction of double-track railways was impossible.

"Flightless" Flights Test Aviators

WITH TELEPHONE AND STOP-WATCH, OFFICERS OBSERVE REACTION OF MEN TO TEST
GAUGES INDICATE TEMPERATURE AND PRESSURE
MASK THROUGH WHICH OXYGEN IS BREATHED
OXYGEN TURNED ON AT TANK WHEN AIR BECOMES TOO THIN
TORTURED FACES OF AVIATORS SHOW SEVERITY OF TEST
EACH MAN HAS SEPARATE OXYGEN TANK
MEN UNDER TEST MAY ASK BY TELEPHONE TO BE RELEASED IF STRAIN IS UNENDURABLE

Duplicating with scientific precision the extraordinary atmospheric conditions of the heights to which aviators must be physically fit to fly, the United States Army Air Service is selecting its personnel by flightless "flights." A steel tube within a building incloses a dramatic scene—tense figures in arctic clothing enduring torturingly rarefied air and using oxygen masks to retain consciousness



The exterior of the ingeniously contrived steel tube that creates artificially the terrific exactions of military aviation to test the physical capacity of candidates for the service, thus saving lives, planes, and money. Note observation officer

THE prospective military air pilots shown here actually are inside a riveted steel cylinder that rests on the ground, although theoretically they are 25,000 feet above the earth. The meteorological conditions at that great height have been scientifically produced in the tank to test the candidate aviators' physical equipment for flying, before they are permitted to risk themselves or a machine in flight.

Twenty-five thousand feet above the ground the temperature is lower than 20 degrees below zero. Refrigerating apparatus lowers the temperature of the tank to that figure. At 25,000 feet the air is so rarefied that pilots must administer oxygen to breathe. So rarefied air is supplied artificially to the tank, and those under test are furnished with oxygen masks for use when the air becomes too thin.

Meanwhile, observers watch through a window the reactions of the recruit flyers to the changes in atmospheric conditions, timing their movements and listening over a telephone to the remarks they make, which indicate how they are standing the test.

By the use of such tests, military aviation authorities believe they can separate the fit from the unfit among prospective pilots, thereby reducing materially the number of accidents attributed to the inability of airmen to withstand great heights.

The same tank is also used to test experienced pilots who are about to attempt flights for altitude records. From France, where the tanks have been used with much success, recently came a story of a military aviator who was forbidden by his superiors to essay a record flight because of his evident suffering while undergoing the tank test. Had he attempted the actual flight, it is said, he might have lost control of his machine and plunged to death.

Apparatus similar to the tank here shown and used for a like purpose is at Mitchell Field, L. I., and other military aviation centers in the United States.

Cheap Motor Fuel from Coal

Ford's New Distilling Process Promises to Save Vast Sources of Power and Light that Now Go Up in Smoke

By Raymond J. Brown

IN TWO power plants, one in Michigan, the other in Canada, Henry Ford has taken what engineers assert is one of the most important and revolutionary steps of the last quarter century in industry.

He has installed apparatus for the distillation of coal at low temperatures for the purpose of extracting certain by-products that heretofore literally have gone up in the smoke from factory chimneys.

To the average man, salvaging the smoke from industrial furnaces would seem to have little bearing on his ordinary life, beyond the possibility of relieving him from breathing smoke-laden atmosphere. And yet the new Ford project concerns the average man even more deeply than it does the industries that it may benefit. For among the promises that it holds forth are these:

Process Improves Bituminous Coal

Huge quantities of an efficient motor fuel cheaper than gasoline.

Cheap and efficient lubricating oils and greases for the automobile.

Cheap illuminating gas.

Cheap oils for fuel and light.

Cheap oils and chemicals (including ammonia) suitable for a wide variety of domestic and industrial purposes.

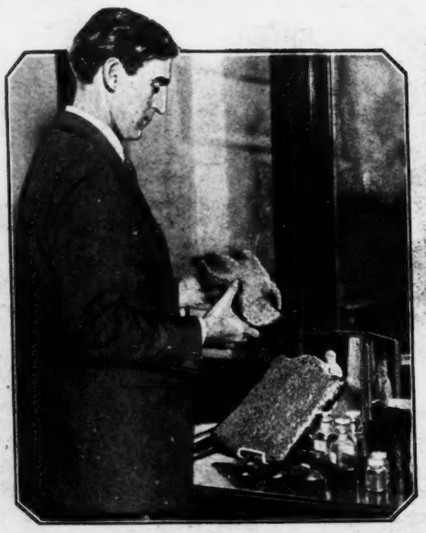
Smokeless fuel comparable in efficiency and cleanliness with anthracite coal.

And all of this, mind you, without affecting in any way the utility of the coal in producing light, heat, and power for industrial purposes!

In other words, an industrial plant may distil the bituminous coal ordinarily burned in its furnaces, to extract from it the motor oil and other by-products that would go up in smoke in the ordinary process of burning, sell these by-products to industrial and household consumers, and then burn the remaining coal as usual to operate its engines or dynamos, because the distilled residue has better heating qualities than the original coal.

This is not guesswork. The facts have been scientifically checked in the laboratory by experts in the Ford employ. It is no more an experiment, for within the next few months, it is announced, the new Ford gasoline substitute and the other coal by-products from the two plants will be on the market.

The project may be called an experiment only in that the quantity of motor fuel, lubricating oil, and similar products to come from the two Ford plants will be inconsequential when compared with the total amount consumed in the country. Although entirely new, the process will not be monopolized. It will be offered to any industrial concerns that may care to install it in their plants. And if, as is expected, other large plants distil their coal before consuming it, quantities of motor fuel and similar products, comparable to the present total output of the petroleum wells of America, can be offered to the public at prices that ought to be amazingly low.



V. Z. Caracristi, one of the engineers who worked out the Ford process of coal distillation. He is shown holding a piece of the smokeless coal from which the valuable by-products indicated below have been removed or "distilled"

The vast quantity of valuable fuel and light products dissipated every day in the smoke of the nation can be appreciated by a consideration of calculations recently offered by consulting engineers of New York City, who assert that the by-products obtainable from a single ton of industrial coal by the process are as follows:

Ten gallons of motor fuel.

From 7000 to 8000 cubic feet of effective illuminating gas.

From 2½ to 3½ gallons of creosote oil.

From 1½ to 2½ gallons of lubricating oil.

From 8 to 12 pounds of lubricating grease.

Twenty pounds of sulphate of ammonia.

A greater or less quantity of a heavy oil of tarlike character suitable for use as fuel.

When it is considered that the annual production of bituminous coal in the United States has averaged almost 500,000,000 tons a year for the last 10 years, it is apparent that the general adoption of the distilling process would make available to the public vast amounts of oils and gas.

In point of interest to the motorist alone, the distillation of 500,000,000 tons of coal, according to these figures, would supply every motor car in the United States with sufficient fuel to run it almost 8000 miles. This is probably greater than the average mileage of most automobiles for a year.

"THE most profoundly interesting possibility of the economic use of fuel of the present day," is the way Ford's coal distillation project is characterized by a fuel engineer of a great American chemical corporation. Professor Jerome J. Morgan, Ph.D., of Columbia University, an expert on fuel chemistry, adds that "the results certainly will be watched with great interest by engineers."

ILLUMINATING GAS 8000 CUBIC FT.
RESIDUE OIL OR TAR
LUBRICATING OIL 2½ GALS.
CREOSOTE 3½ GALS
MOTOR FUEL 10-GALS
SOFT COAL 1 TON
LUBRICATING GREASE 12 LBS.
SULPHATE OF AMMONIA 20 LBS.

Valuable fuel, light, and lubricating products obtainable from a single ton of coal and now wasted in smoke

To Distil 4400 Tons Daily

The Ford plants where the coal distillation is to be carried on now are under construction at River Rouge, near Detroit, Mich., and at Walkerville, Ont., Canada. The Michigan plant will distil the 4000 tons of coal it expects to consume daily in its operation. The Canadian plant will distil 400 tons a day. Both will be in operation within a few months. In connection with the amount of coal that these plants will use, it is probably well to note that engineers who have investigated the new process of coal distillation report that it probably would be unsuitable for use in places where normal coal consumption is less than 400 tons a day.

The distillation of coal is no new process. It has been practised for years in the production of illuminating gas and coke, in which high temperatures—about 2500 degrees—always were employed. Always when attempts were made to distil at low temperatures, coals and tars were found to stick to the mechanism of the furnaces and retorts, interrupting the operation—a difficulty, by the way, that was not entirely unknown in high-temperature distillation. In high-temperature distillation, too, the excessive heat was inclined to bring about chemical reactions in some of the products while they were in the gaseous state, altering their chemical constituency and making them useless. Maintenance of the high temperatures also was expensive.

So, although chemists long have believed that a low-temperature distillation process would result in the extraction of important substances from coal, until the Ford experiments began, no low-temperature process had been devised. The chief products of coal distillation remained illuminating gas and coke.

The Ford method was worked out by V. Z. Caracristi and Emil Piron, New York engineers. The basic idea of their system

Wasted smoke from America's coal supply represents potential motor fuel sufficient to drive every car in the United States for a year, according to chemical engineers working on the problem

is highly ingenious, yet extremely simple. Molten lead is employed to transfer the heat for distillation. A great pool of this metal, heated to 1100 degrees, lies in a huge furnace. Over its surface is carried an endless conveyor of iron plates or pans, hinged together. Since these pans are of lower specific gravity than the lead, they float on the pool as wood floats on water. On them powdered coal is spread about half an inch thick.

As the pans float through the oven, they are heated more rapidly than would be possible were the heat from flames to pass to them through the air, because lead conducts heat 80 times faster than air. The heat of the pans, of course, is transmitted to the coal they carry, and the coal breaks into its gaseous constituents. These gases are gathered, cleaned, and separated for further treatment. After the pans pass out of the furnace, the residue is removed from them.

How Smokeless Coal Is Burned

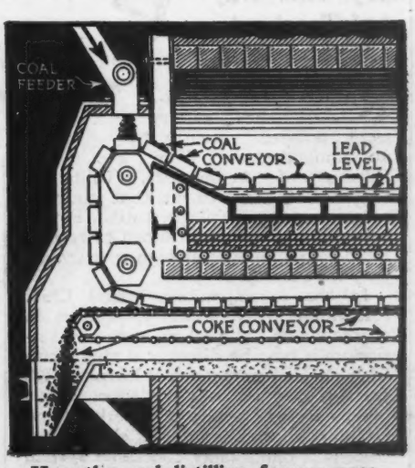
The residue is a coal agglomerate similar to coke, and giving no smoke. It can be converted into briquettes of an anthracite character for domestic or industrial use, burned in powdered form in special furnaces, or ground and mixed with high volatile coal to make metallurgical coke.

This apparatus is said to be not only simpler than the furnaces and retorts commonly employed in the distillation of coal, but less expensive in installation and operation.

Mr. Caracristi recently called the Ford process a "flank attack on some of the elements contributing to the high cost of power and gas and to the cost of fuel for domestic purposes, at the same time providing a source of supply of light oil to meet motor fuel requirements."

Places where engineers say the process may be employed effectively include mines, power stations, gas plants, factories, railroads, and distilling plants where sawdust and other forms of wood are used for the production of wood alcohol, acetic acid, and pitch. The railroads first would distil their coal, then use the anthracite-like residue to run their locomotives.

Industrial concerns using coal in large quantities are observing the Ford project with eager interest. They recognize its economic value provided the by-products have a market value greater than the cost of installing and operating apparatus for their extraction—a requirement that must be demonstrated before the general adoption of the Ford process may be hoped for.



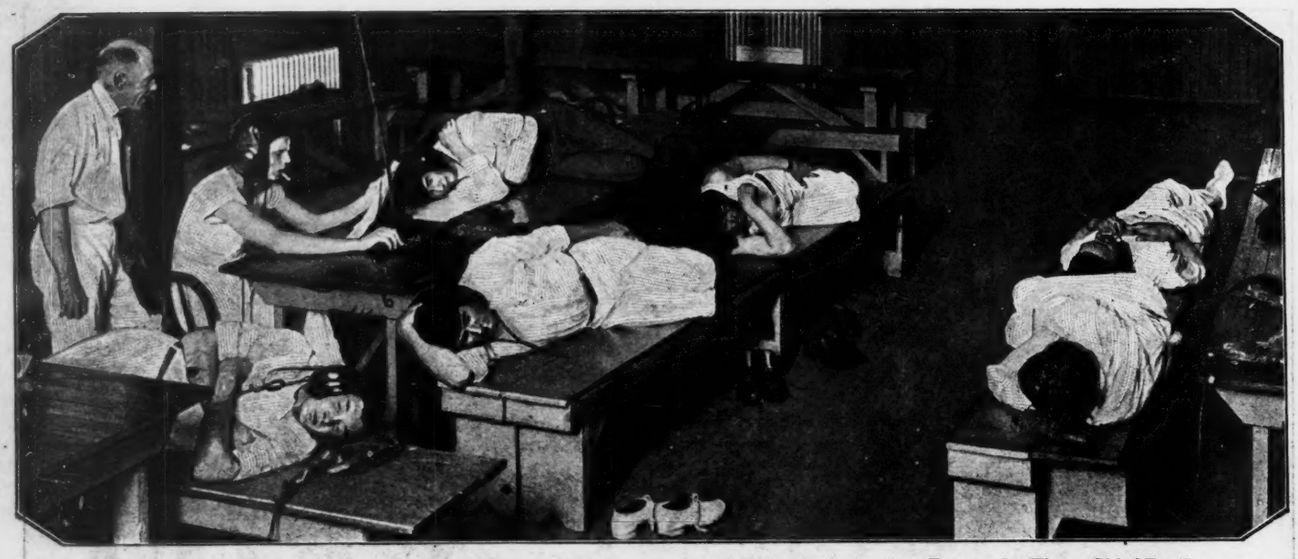
How the coal-distilling furnace operates. Powdered coal is carried in conveyor pans moving over a pool of molten lead. The intense heat breaks the coal into its gaseous constituents, which are gathered and transformed into by-products. The smokeless, coke-like coal, a high grade commercial fuel, is carried off by a second conveyor

By distilling coal before burning it for industrial purposes, a saving of not less than two dollars a ton will be effected, say the engineers who have designed and installed the distilling apparatus. That is to say, the motor fuel, lubricants, and other by-products extracted by distillation can be sold at prices that will cut not less than that amount from each ton of coal normally consumed. They add that in factories and other plants using large quantities of coal, the saving resulting from distillation will be sufficient to defray in a short time the cost of installing the special furnaces which the process requires.

Engineers Confident of Profit

Six months, or at most a year, the Ford engineers assert, will be required to demonstrate that low-temperature coal distillation can be conducted cheaply enough to bring a profit. Their experiments at the Ford coal mines in West Virginia, they say, already have proved this fact to their satisfaction. They have expressed themselves as certain that the practical operation of the plants in Michigan and Canada will prove it to the rest of the industrial world.

They are making no promises and few predictions, but many who have given close study to the various aspects of the Ford plan profess to see in it future possibilities of immense interest to the average man and his pocketbook—including a realization of the motorist's dream of ten-cent gasoline.



Sleeping student aviators learning to receive high speed code messages at the Naval Air Station, Pensacola, Fla. Chief Radioman J. N. Phinney, discoverer of this remarkable method, and author of the following article, is shown standing at the extreme left

How to Learn Radio while You Sleep

By J. N. Phinney
Chief Radioman, United States Navy

IF YOU wish to become an expert radio operator or land telegrapher quickly, learn while you sleep.

Go to bed with your head phones over your ears or within sound of a clattering telegraph instrument, and in an almost unbelievably short time you will be able to receive code messages at a speed that will amaze you.

That is the way I learned telegraphy as a boy. That is the way the Bureau of Aeronautics of the United States Navy now is teaching radio transmission and reception to student aviators. The method is past the experimental stage. It may be said to have become a standard system of instruction, since I demonstrated recently its practical value at the naval air station at Pensacola, Fla.

Eminent psychologists have given an explanation of the brain's strange faculty of absorbing and retaining information during sleep. The subconscious mind, they say, continues to function while the body and the conscious mind lie dormant.

Without attempting to explain the phenomenon from the psychological standpoint, I can speak authoritatively with regard to the way in which the "learn while you sleep" method worked out in my own case. I can describe, too, our experiments at Pensacola, which are borne out by Navy Department reports and by the written statements of the students who benefitted by the experiments.

At the age of 17 I landed my first job as a railroad telegrapher, handling a night trick on a slow line. Slow as the line was, however, I was slower still, and I soon was forced to the conclusion that, unless I increased my speed at once in some miraculous manner, I was likely to find myself out of a job. I slept beside the main line relay, which was always clattering away much faster than I could copy. In a surprisingly short time I found myself able to read the fastest operator on the line. The miracle had occurred. Somehow I had learned while I slept.

Years later—in 1914—when I was radio operator at the naval radio station, Jupiter Inlet, Fla., I found myself obliged to receive messages from a crack operator in Jacksonville whose speed was much too great for me. I decided to make an experiment. For several nights I slept beside an electrically driven automatic sending device. At the end of that time I found myself able to take all the Jacksonville operator shot at me and ask for more.

That decided me. If I could learn radio and telegraph codes during sleep, why couldn't I learn other subjects in the same way?

To investigate, I set up many sorts of automatic dictating devices at my bedside and at the bedsides of others. The results of these experiments convinced me that I had fallen upon a method of teaching telegraphy that was quick, easy, and certain.

My first opportunity to try it out came a short time ago when 12 naval medical officers started our flight course. One, a noted specialist in psychology, expressed a desire to try my method. A single night with radio messages throbbing in his ears as he slept enabled him to copy radio with much greater ease, accuracy, and speed than ever before, and the result of his report gained me the coveted opportunity to conduct further experiments with official sanction.

Tests with enlisted men were carried out among students who were so backward about learning radio that failure appeared certain. Seventeen volunteered for a test. The following results were noted the next day:

One of the 17 copied five words a minute faster than before. Four copied three words a minute faster and one nearly three words faster. Four copied two words faster, and one nearly two words faster. Three copied one word faster and one half a word faster. Two slept on the floor and caught a cold and headache respectively. Six subsequent tests have been made on these students, with the result that radio has lost its terror for them and they have averaged a gain of three words a minute each night in receiving ability.

The instructors derive some amusement to compensate them for their loss of time and sleep by watching the facial contortions, restlessness, and mutterings of the students under test. Errors and uneven sending cause restlessness and muttered protests.

We are using the new system at Pensacola not only as a life line for those who are about to be dropped from the class, but to give those who seem to need it a chance to enjoy its benefits early in the course.

Since the "learn while you sleep" system has so fully proved its value, we have replaced the hard wooden benches and tables of experimental days with the regular army cot for the radio students. It has been established that the men learn just as rapidly when sleeping in comfort as in discomfort.

Try This Way of Teaching Yourself

RADIO fans throughout the country were amazed recently by an announcement from the Bureau of Aeronautics, United States Navy Department, that student aviators at the naval air station, Pensacola, Fla., were being trained to receive radio code messages at high speed while they were asleep.

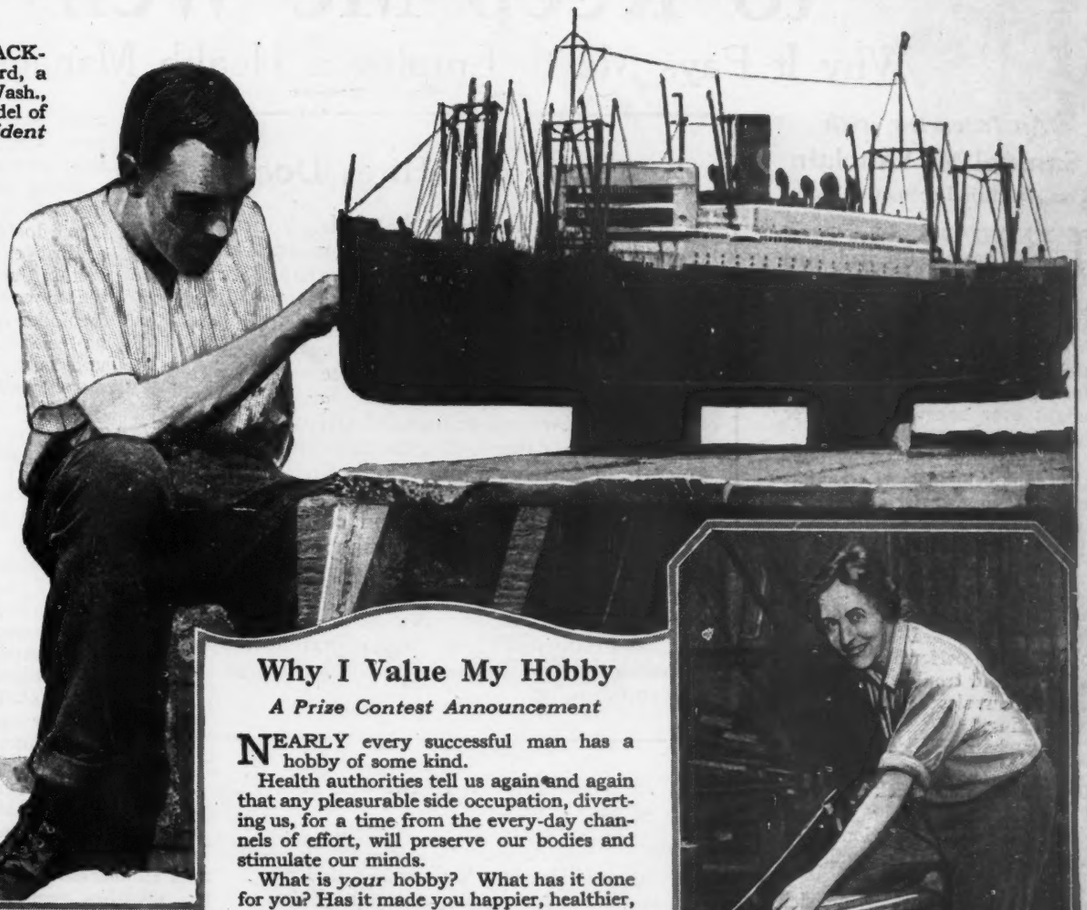
In the accompanying article Chief Radioman J. N. Phinney, who is in charge of the radio school at the air station, tells how he discovered this seemingly miraculous method of learning. He explains how he uses the subconscious mind's strange faculty of absorbing and retaining information during sleep as the basis of a remarkably successful system of instruction. He shows how you can employ this system in learning, not only radio, but other subjects that require the exercise of memory and quick thinking.

Try this method on yourself. Put on the head phones when you go to bed. See how much you can learn while you sleep.

My Doctor Is under Contract

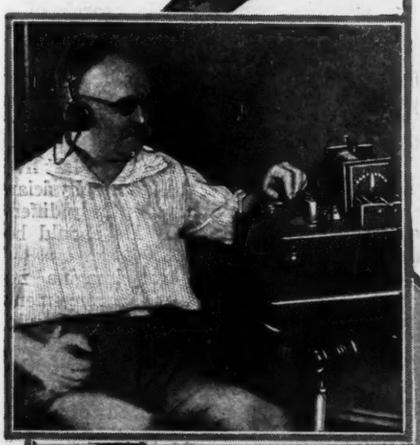
They Find Happiness in Hobbies

And Health in Useful Relaxation from Business or Profession



USING ONLY A JACK-KNIFE, L. A. Maynard, a mechanic of Seattle, Wash., carved an elaborate model of the Oriental liner *President Grant*, shown at the right. The model was built on a scale of one eighth of an inch to the foot, and is a perfect detailed reproduction. It was carved, bit by bit, during Maynard's spare hours, from a block of cedar, the work requiring 13 months of enjoyable and healthful labor

HAPPY THOUGH BLIND, Patrick O'Keefe, hero of the New York City Police Department, keeps in touch with world affairs by means of a crystal radio set which he built himself. He is shown listening-in with his homemade radio receiving apparatus



Why I Value My Hobby

A Prize Contest Announcement

NEARLY every successful man has a hobby of some kind.

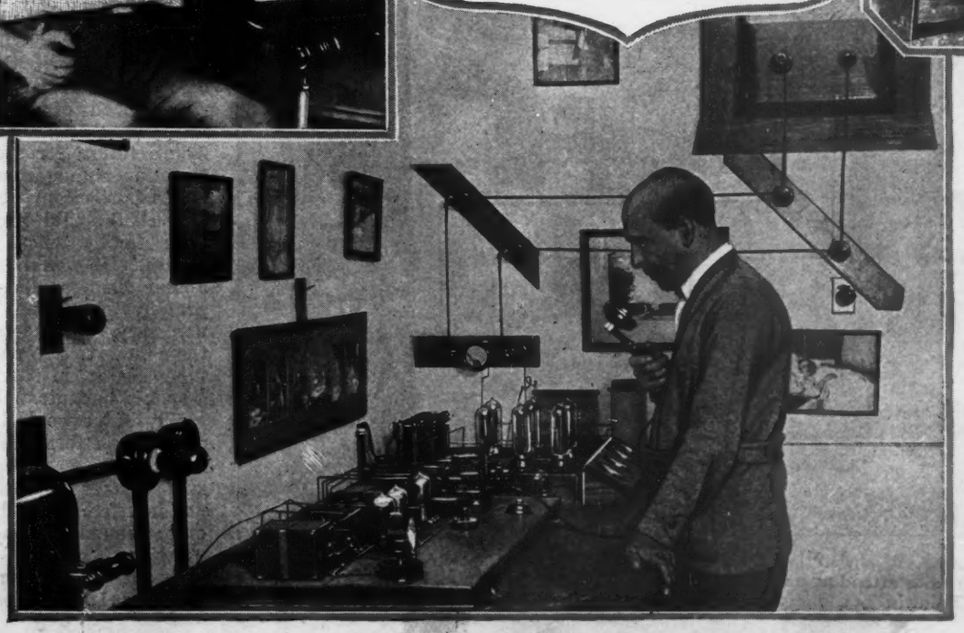
Health authorities tell us again and again that any pleasurable side occupation, diverting us, for a time from the every-day channels of effort, will preserve our bodies and stimulate our minds.

What is *your* hobby? What has it done for you? Has it made you happier, healthier, more successful? And how?

Write and tell us about it. For the best letter of not more than 400 words, accompanied by a photograph of yourself at your hobby, we offer $20, first prize; $10, second prize; $5, third prize.

Address letters to Contest Editor, Popular Science Monthly, 225 West 39th Street, New York City. Each letter will be considered by a board of editors whose decision will be final. Competition closes November 20, 1923. Winning contributions will be published in the March, 1924, issue.

CABINETMAKING is the hobby of Miss Dorothy Moore, New York art student, who in her spare hours has trained herself to be an expert carpenter. She has specialized in working on unusually fine pieces of antique furniture, repairing broken parts, and building in new ones



RADIO DE LUXE is the pastime of Charles Erbstein, noted criminal lawyer of Chicago, who at his home four miles east of Elgin, Ill., operates one of the finest privately owned radio broadcasting stations in America. He is shown at the left talking into the microphone at his own station, WTAS

My Doctor Is under Contract to Keep Me Well

Why It Pays Me to Employ a Health Manager

An Interview with
Samuel M. Vauclain
Pres., Baldwin Locomotive Works

UNTIL 1918, when I was 62 years old, I had been able to better the boast of those persons who assert that they never have been sick a day in their lives. I never had been sick for so long as a minute. In fact, even the possibility that I might ever become sick never had occurred to me.

My attitude toward my physical condition, in short, was that of the average person who is blessed with strength and abundant health.

And then I contracted influenza. The experience of lying in bed, forced to rely on others for the services I always had been able to perform for myself, annoyed and troubled me. During my convalescence I did a lot of thinking.

Why had I become sick? Could I have prevented it? Was I likely to become sick again? How might I avoid it?

These were the questions I asked myself, over and over again. Finally I reached a decision.

"Doctor," I said to my physician one day when he called, "I've been sick, and I haven't liked it. I don't want it to happen again—if it's possible to prevent it. Is it possible?"

"I believe it is," he said after a moment's hesitation.

"Very well, then," I said. "I'll make a contract with you. Keep me well for 10 years, and I'll pay you a flat sum every year, the amount to be increased each year on the assumption that, the older I grow, the more difficult it will be for you to keep me well.

"On my side, if you will try to keep me well, I will agree to do everything you say, submit to as many examinations as you wish, follow any diet you prescribe, work as many hours as you say, refrain from work when you advise—I'll put myself entirely in your hands for 10 years. But you *must* keep me well. If I fall sick, you must pay a penalty. I shall make deductions from your annual retainer according to the length of time I am sick. I don't expect you to achieve the impossible, however. Should I suffer any serious, incurable illness, which you could not have prevented, the contract is to be cancelled. Will you enter into such an agreement with me?"

"A real contract?" he inquired.

"A real contract," I declared, "in legal form, binding and actionable at law."

He thought for a moment. Then he nodded briskly, signifying his acceptance.

Five years have passed since that contract was made. I have kept my part of it, and my doctor has kept his. Except once or twice when it was necessary for me to make long journeys, I have been examined not less than every two weeks, and have guided myself entirely by the doctor's instructions. In that time I have not lost a day from business, nor have I been ill in any way. I am heavier, stronger, and more active than I was five years ago, and my capacity for work seems to be greater.

Being under a doctor's care has been in no sense a hardship. The doctor has warned me against excess with regard to certain foods, but he has not placed me on a diet. He has not forbidden me to smoke nor has he insisted that I retire at any unusually early hour. I am merely leading a normal, healthful life, suitable to a man of my years, with a competent physician to guide and advise me.

What I am doing may be unusual, but I consider it sensible and logical. It is nothing more than utilizing in the care of my body the same principles that I have been using for years in the care of my business. No one would think of attempting to conduct a business enterprise without a capable manager. Why not, then, a capable manager for your body?

The human machine, like any other machine, will wear out. It demands attention and repairs. After you buy an automobile, you must inspect and repair it frequently if you expect to keep it running efficiently. The sensible man in business does not wait until he is in trouble, then rush away in search of a lawyer to get him out of it.

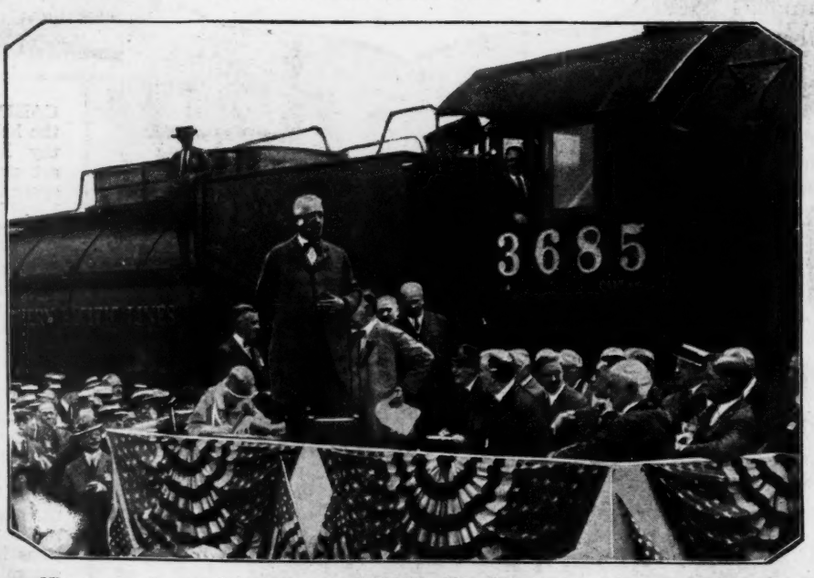
Why, then, should people wait until there is serious bodily trouble before they call for a physician? Is their health of less value to them than their automobile, or their business?

From my own experience of the last five years I should say that the family physician should be placed on a basis entirely different from his present one. He should be consulted before illness.

I can imagine no happier arrangement than one that would place, say, 25 or 30 families under the care of a physician to whom each of them would pay an annual fee in return for systematic and regular medical attention. The physician would visit each family once a month. He would examine its members, prescribe for them if necessary, and advise them how to preserve their health, in short, *keep* his patients well.

Physicians would be able to perform this service for a reasonable fee, for it would not interfere with the other demands of their practice.

Such a system, universally adopted,



Vigorous and powerful at the age of 67, Mr. Vauclain is shown here speaking at ceremonies attending a recent shipment of 20 great oil-burning locomotives from the Baldwin Locomotive Works at Eddystone, Pa., to a railroad in Texas

Kansas Town Hires Doctor

CONVINCING proof that Mr. Vauclain's unusual health contract plan, described in the accompanying article, is entirely workable not only for individuals and family units, but even for entire communities, is offered by Sharon, Kansas, a town that once had no physicians. Here the announcement by a prominent family that it would have to move to another town where medical attention would be available caused Sharon residents to cooperate in devising a plan to obtain a community doctor of their own.

They formed an association of about 1000 farmers and townspeople, brought a doctor to Sharon, and signed an agreement with him. Each member now pays $15 a year for medical services for his family. Not only has the plan cut down doctors' bills, but it has decreased remarkably the disease and death rates in the community.

Printing Made Audible for the Blind

SAMUEL M. VAUCLAIN, president of the Baldwin Locomotive Works, is a living proof of his contention that assurance of good health and success in work go hand in hand. Since his birth at Port Richmond, Philadelphia, 67 years ago, his career has been a steady march upward. He started work, at 16, in the Pennsylvania Railroad shop at Altoona. Thirteen years later he became superintendent of equipment for Burnham, Williams & Co., Philadelphia, proprietors of what now is the Baldwin Locomotive Works. The next year he became general superintendent; a member of the firm in 1895; vice-president in 1909; senior vice-president in 1917, and president in 1919.

Vauclain is credited with being responsible, more than any one, for the modern compound cylinder locomotive. In proof of his genius, the Eddystone plant of the Baldwin Locomotive Works this fall smashed all records for production, turning out 31 locomotives weighing from 350,000 to 400,000 pounds each in 31 hours, or one every hour

would pay enormous dividends in health and happiness.

Every one suffers physically and financially during illness. The majority of men who earn their bread with their hands are not paid at all when they fail to report for work, whether their absence is due to illness or other causes.

And so I say, go to your physician and let him examine you. If you are well, it will be cheering for you to hear him say so. If you are not well, he will tell you how you can become so. Follow his advice and make your visits to him frequent. This is health insurance of a practical sort. The premium rate is small; the value of the policy enormous—the safeguarding of your own life, health, peace of mind, and efficiency.

Making a Power Plant of Your Ford

Printing Made Audible for the Blind

A CLEVER invention that transforms printed or typewritten matter into sound is science's latest offering to the blind. Once the blind operator has learned facility in the use of this device, it is claimed, he can read with several times the speed possible to the reader of raised writing, the famous Braille method, now in universal use among blind students. Moreover, the blind "reader" is given access to a vast amount of printed matter which never would be put into raised writing.

This transmutation of printed matter to sound is accomplished by virtue of the remarkable sensitivity of the element selenium to light. This element offers varied resistances to electricity, these being determined by the strength of the light to which it is exposed. It is this property that finds employment in selenium cells.

The "optophone," which transmutes printed matter into sound by utilizing a peculiar property of selenium, making a vast store of knowledge available to many thousands of blind persons

In the "optophone," a selenium bridge is exposed to successions of light pulsations, which vary according to the forms of the letters in the printed line. These variations are made electrical by the varying electrical resistance of the selenium. These electrical variations are transmitted as sounds to the blind "reader" through a telephone headpiece.

A characteristic sound is produced by each letter and symbol, so that a sound alphabet, said to be easily learned, results.

Garage Opened while Sitting in Your Car

JUMPING out from behind the wheel to open the garage doors when ready to run the car in for the night has frayed the temper of many a motorist after an otherwise pleasant day's trip. Now a man in Portland, Ore., has devised a method of opening the garage merely by pushing a knob while remaining in the car.

From the house runs a water pipe to an underground tank beside the garage. From this tank a pipe connects with a cylinder and piston hung horizontally along the length of the garage at the height of the door. A knob, set in a post at a height convenient to the driver's seat, controls the flow of water into the tank.

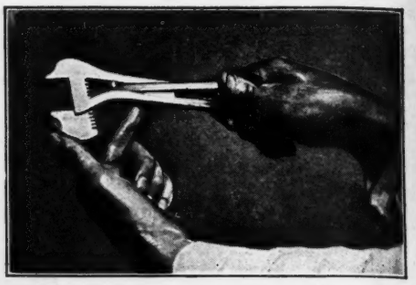
When the tank is filled, the air it contained is forced through the connecting pipe into the cylinder. The piston is driven by the pressure of air, operating two metal arms that throw the garage doors open.

As long as the water pressure is maintained in the tank, the doors remain open. A weight attached to a pulley pulls them closed when the water pressure is released, for the air, rushing back from the cylinder, causes the tank to be drained.

An automatic lock holds the doors closed until they are opened by the apparatus.

The post, with a knob controlling the water content of a tank. When full, the tank forces air into a cylinder, opening the garage doors

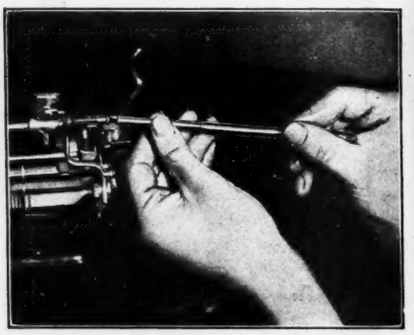
Turning this handily located knob opens the garage doors



An Easily Adjusted Wrench for Odd Corners

ONE jaw of this quickly adjustable wrench is rigid, while the other is movable and supplied with teeth, which are engaged by a lever pivoted in the handle when the desired adjustment has been made. It is useful for working in odd corners.

Stubborn Screws Mastered by This New Driver

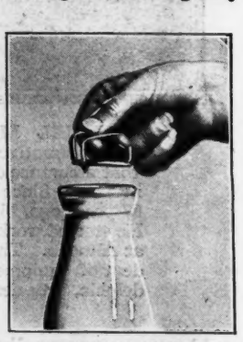


HAVE you ever, with mounting rage, picked up for the sixth time a screw that you were trying to insert, and could not, because your hand could not reach the inaccessible spot where it should go in? Or perhaps you were on a stepladder and needed one hand for support.

The ingenious screwdriver here illustrated would have spared your feelings. A pressure of the handle projects two spring clips that hold the screw tightly until it is safely started. Releasing the pressure withdraws the clips and the screw can then be driven in in the usual way.

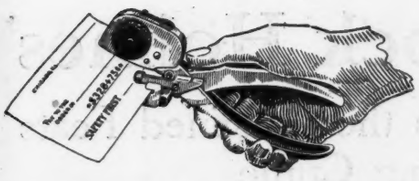
The Milk Bottle Is Tamed

THIS recently patented cap remover promises to tame the squirting milk bottle, to banish along with the other woes of yesteryear the staining dribbles of greasy white that attacked you when you were in a particular hurry.



Pressure on the arm of the invention causes a barb to pierce the cardboard. A gentle upward lift then takes the cap from the bottle. Pressing a small spring releases the milk-bottle cap from the barb.

The device replaces the cap as handily as it accomplishes the removal, an added advantage, for it is in this replacing that the worst disaster often lurks.



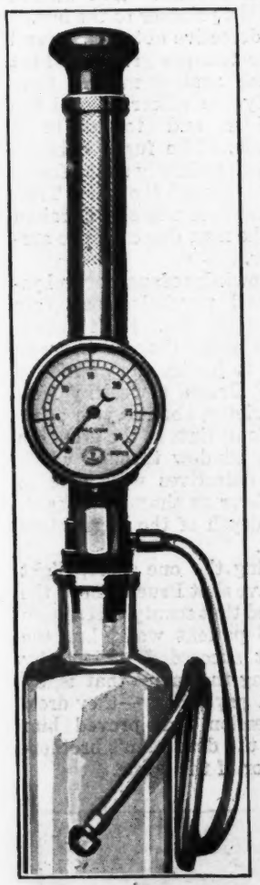
A Punch Check Protector Weighing Eight Ounces

THIS handy check protector can be carried in your suitcase, or even in your pocket.

It weighs about eight ounces. The device operates much as does a conductor's punch, the inked characters being forced into the fiber of the paper. The correct position of an impression is assured by a simple gage. The feed is automatic.

Small Hand Vacuum Pump Has Many Utilities

A HAND vacuum pump with a gage for use where the container to be exhausted is small, is a recent device offered doctors, dentists, chemists, and laboratory experimenters, to meet the now widespread need for a handy, quick means of creating vacuums.



A rubber cork that fits a standard bottle tightly is attached to the pump, so that operation of the plunger creates a vacuum in the bottle. The suction hose is attached at the side of the pump, near the cork, the liquid or other matter passing into the bottle and not into the pump or gage. It is said to lift liquids 25 feet.

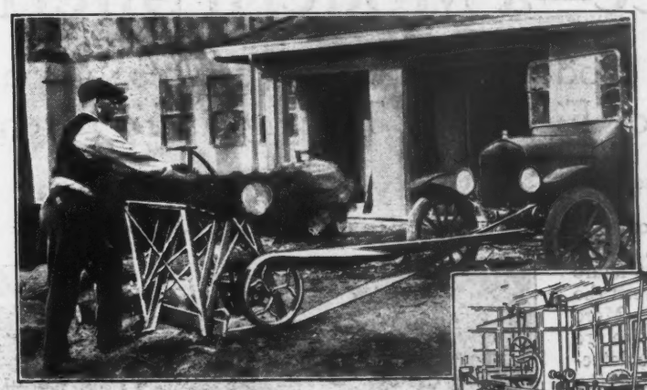
Besides its utility to those mentioned above, the device should prove useful to draw liquids from steam traps, the base of motor boat engines, etc.

Stationery for the Blind

BLIND persons may write letters now without lines that straggle up and down the sheet. The idea that makes this possible, that of perforating lines on stationery with an unthreaded sewing machine, was conceived by Mrs. E. F. Coyle, of Bartow, Fla., who used it first to help a blind relative.

The lines are made amply wide apart. The writer follows the line with the forefinger of the left hand. If the little finger of the right hand is allowed to rest on the paper, the writer will know when the edge is reached.

Making a Power Plant of Your Ford

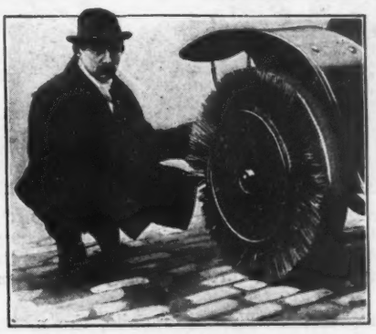


Left: The power pulley and a Ford sawing logs. Below: Sketch showing how the pulley enables an auto engine to run a small workshop

A POWER pulley that makes a mobile power plant, adaptable to home, workshop, or farm needs, out of a Ford is the latest achieved success of inventive genius in making your automobile a more accomplished mechanism.

The simplicity claimed for the invention is striking. No jacking up of the car or changing of wheels is required. The device is attached to the car near the starting crank, by any one and within a few minutes. It is fairly small and unobtrusive looking, so that it need not be detached when not in use. To put the invention to work, one slips the belt over the pulleys, backs the car to tighten the belt, and starts the engine. Speed is automatically controlled by a variable speed governor that controls the gas feed. A considerable resultant gasoline saving and the prevention of engine racing are claimed for this governor. A clutch throws the power off and on, so that stopping and starting the engine is unnecessary.

Those who have observed automobile engines when they are developing maximum power will realize that this invention enables a Ford engine to run a small workshop.



Mud-Spattered Pedestrians Befriended by Inventor

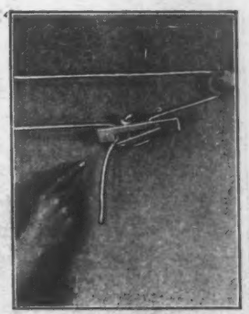
MOTOR-CAR wheels are said not to splash mud on pedestrians when equipped with the brush here illustrated.

The photograph is from Paris, where a thoroughgoing series of experiments recently was conducted to determine the most effective means of splash prevention.

Your Clotheslines Need Not Be Slack Now

SLACK clotheslines can be avoided by use of this rope-joining clamp.

It consists of two pieces of hard wood, one recessed and receiving a short strip in the recessed portion. Two holes are in each block, alined so that the rope may be threaded through one hole in each and back through the other hole in each. A third hole is close to the end of the recessed portion of the larger block and the rope end extending through it is engaged by the smaller clamping block.



A Berth for the Baby in a Motorcycle

The baby goes riding, too, in his safety hammock

SPECIAL sleeping accommodations for the baby are now possible when the family goes out for a Sunday in its motorcycle car. These useful three-wheeled modifications of the trailer idea are thus made still more effective competitors of the small family car.

The inventive dad who figured out this hammock saw to it that baby was made as comfortable as soft places and shelter from shocks could make him. The movements of the car, as conveyed to the hammock, are converted into an easy, pleasant motion.

The inventor says that his baby never succeeded in getting out, adding that if his baby cannot, no baby can.

This use of practical psychol-

Through finger-prints acci-

Science—a Modern Sherlock Holmes

Exploits of Today's Police Detectives Surpass the Imagined Feats of Fiction in Tracing and Preventing Crime

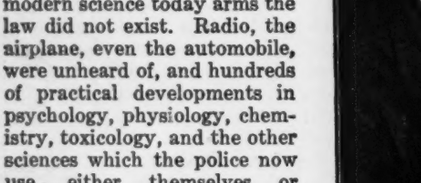
By Richard E. Enright

Police Commissioner of New York City

RECENTLY the scientific detective, who previously existed only in books and on the stage, has become a real and potent figure in the endless war between the police and the criminal. More and more American police are employing science in the detection of crime, surpassing the imaginary exploits of Dupin and Sherlock Holmes, because when Poe and Doyle created their fictional heroes the extraordinary tools with which modern science today arms the law did not exist. Radio, the airplane, even the automobile, were unheard of, and hundreds of practical developments in psychology, physiology, chemistry, toxicology, and the other sciences which the police now use, either themselves or through experts, had not yet been achieved.

When a woman murderer escaped from a California prison a few months ago, she used a swift motor car and an airplane in her flight across the Mexican border. But the police called upon the possibilities of modern science far more prodigally in pursuing her.

Fred Sandberg, of the Washington, D. C., Police Department, said to be the greatest finger print expert in America, reading the story of a print through a magnifying glass



© Keystone

Chemically intensifying fingerprints on a window pane

Motor cars, motor boats, radio, the telephone and telegraph and airplanes were pressed into service in spreading the net that eventually enmeshed her.

This instance illustrates a dramatic feature of the bitter warfare between the police and the criminal. For years the latter has made eager use of the new developments in science to further his depredations against society. The oxyacetylene torch, for example, by whose fierce heat the stoutest metals may be cut like butter, was quickly seized on by the safe-cracker, who has used as well the most violent explosives devised by the chemist. The automobile, the motor boat, and later the airplane, are used by the burglar, the bandit, and the drug runner.

It has been only by keeping several steps ahead of the criminal in the employment of scientific weapons that the police have been able to cope with him.

Nowadays the detection of crime has become an exact science, founded on very definite principles. Like all other sciences, it promptly applies new developments in other fields to its purpose.

A month or so ago a squad of police in New Jersey went to arrest a former convict wanted for bank robbery. He opened his door at their knock and turned an automatic pistol on them, killing two and mortally wounding two others. Then he fled to the attic, closing a trapdoor on his pursuers. There was no escape for him. But how was he to be captured? He was armed and had shown that he would not shrink from murder. Starving him out was likely to prove a long and dangerous process. But science gave the prisoner to the law.

A detective obtained several of the tear-gas grenades, kept for use against mobs. Cautiously the officer opened the trapdoor and tossed in a grenade. The fugitive began to cough painfully as the fumes spread through the attic. Then the trapdoor was slowly raised and the man descended to surrender.

Knowledge of anatomy, physics, and psychology, too, are vital to the law. Such knowledge enabled the authorities to bring to justice the murderers of "Honest John" Bruen, a wealthy New Jersey circus proprietor, about a year ago.

From a pair of footprints in the ground a few feet from the window through which Bruen was shot, detectives were able to describe the murderer as short and slight, facts read in the depth of the impressions and in their shape.

The job of finding the one short, slight man who might have shot Bruen among the many who answered that scanty description required long and patient work, but the detectives at last succeeded. Then, by adroitly questioning the man—that is, by the use of applied psychology—they drew from him a confession that proved him the murderer and the dead man's brother-in-law the instigator of the crime.

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Radio, machine-gun, and motorcycle car combined is a swift and deadly pursuer of violators of the law

© Keystone

Broadcasting a police alarm. This radio apparatus has a range of 30,000 square miles

Copy Holder Prevents Eye Strain

This use of practical psychology—or, to call it by a simple name, keen understanding of human nature—is one of the most effective weapons of the modern detective.

Not long ago a New York detective was asked to find who had caused a package of valuable securities to disappear from the vault of a great banking institution. The four employees who had access to the vault were sent to him one at a time. Twenty minutes later one had confessed.

Psychology in Action

Assuming that the four employees, informed that they were to be questioned by a police officer, would expect to be treated more or less severely, the detective adopted an attitude anything but formidable.

The guilty man, prepared to offer defiant denial of any knowledge of anything connected with the theft, was disarmed by the detective's manner.

"If you know anything," the officer said, "I'd advise you to speak. There's ——," mentioning the name of one of the employees previously interviewed. "I hate to think he did it—a young man, married only a year, with a baby and a little home he's just bought."

He continued in similar vein, never once suggesting that he suspected the man before him, leading him to believe that the other members of the department, "——" particularly, were under suspicion.

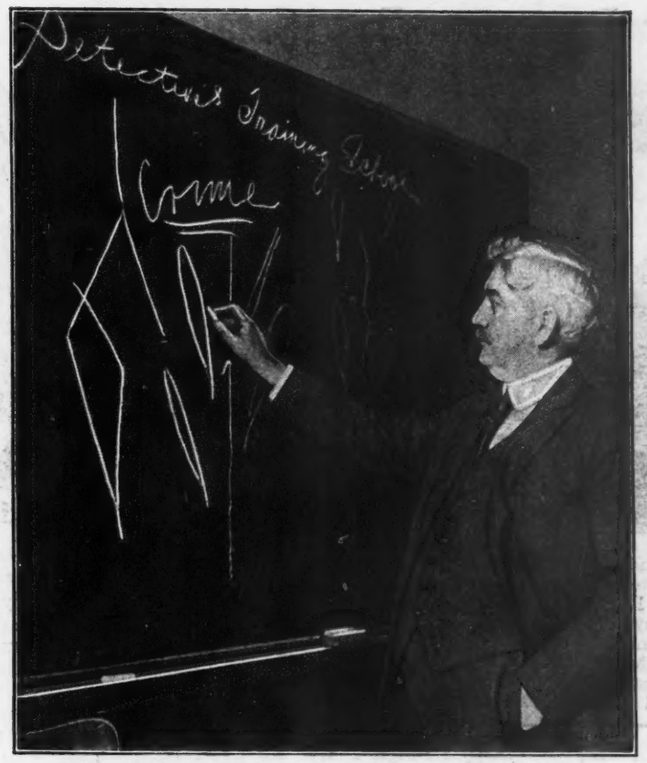
At last the clerk broke down and confessed. He wanted to escape suspicion and punishment, of course, but he was not able to see a man who had worked beside him suffer for his wrong.

The detective who understands practical psychology can vary his form of questioning to get the information he desires from habitual criminals and amateurs alike.

Psychology is a major subject in the school for detectives that we opened recently in the New York Police Department. Study of mental impulses, emotional stresses and motives is made. Members of the department are taught, too, to better their memories and sharpen their perceptions by the use of psychological principles.

Criminology also is studied, the policeman being taught to differentiate between the various criminal types and to use definite methods of approach and questioning in his investigations.

Practical details of police work, such as shadowing suspected persons, concealing identity, and using descriptions to pick persons from a crowd, are taught by means of clearly defined principles.



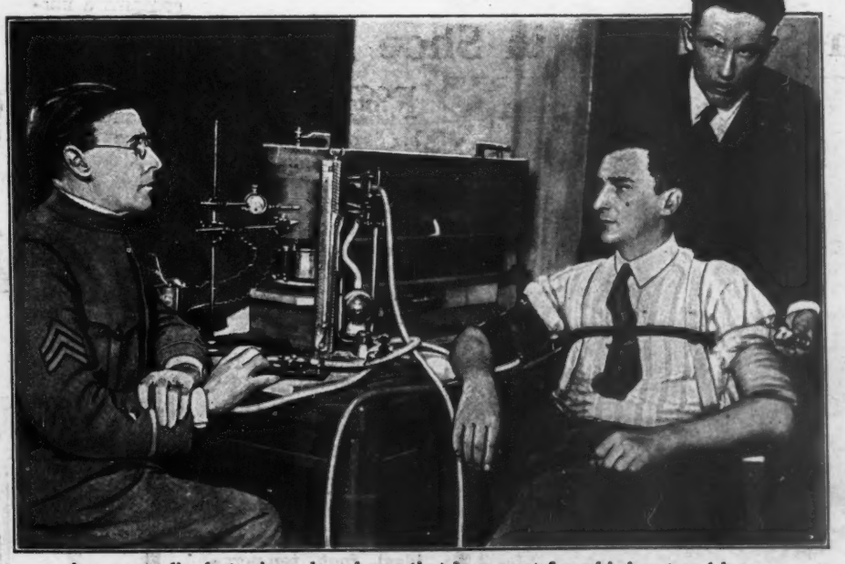
Richard Enright, Police Commissioner of New York City and author of this article, illustrating a lecture before that city's famous detective training school, which he founded

CRIME costs Americans unnumbered millions annually—more than enough to pay the nation's income tax. An impressive share of this is paid directly or indirectly by your pocket. Every advance of criminal science, by making crime more perilous and hence less attractive, saves you money and guards you from harm.

Commissioner Enright, one of the world's most distinguished authorities on crime and criminals, here outlines the scientific technique of the modern sleuth.

He goes farther, venturing this startling prophecy:

"In time science will cause premeditated crime virtually to vanish from the earth."



A man can lie, but science has shown that he cannot force his heart and lungs to lie also. A false answer accelerates their action and the apparatus shown above records these variations, revealing the probable falsehood they betray

Through finger-prints accidentally left at the scene of the crime, every one who reads the newspapers knows, the perpetrator is frequently discovered, scientific methods having been devised of intensifying prints left on doors, articles of furniture, weapons, and window-panes, so that they may be photographed. With the coming of radiophotography, these finger-prints, and in some cases actual photographs of the criminals, will be flashed all over the country within a few minutes after the discovery of a crime.

How Chemistry Helps

Chemistry and the microscope are additional scientific means frequently employed in investigating crime. In detecting bloodstains on clothing, studying inks and paper in forgeries and similar cases, investigating arson, narcotic and poisoning cases and in the performance of autopsies, chemistry is widely used, with the microscope as a valuable adjunct. More than once the analysis of mud on a prisoner's shoes or clothing has proved his presence at the scene of a crime. Under the microscope, typewriting done on different machines and by different persons has been shown to possess as many points of variance as the penmanship of individuals, a fact that has proved invaluable in the unraveling of many crimes in which typed documents were fundamental evidence.

The action of the heart is the basis of a number of methods for compelling prisoners to tell the truth. The heartbeat, the blood pressure, and the rate of breathing, medical men have found, vary considerably under stress of sudden excitement, such as might be occasioned by hearing a damaging question and endeavoring to supply an untruthful answer. Accordingly, there has been devised apparatus, which, when connected with the subject's body, records graphically the action of the heart and lungs and shows variations that may arise from the mental strain of fabricating an answer to a pointed question.

The recent remarkable development in radio communication already has been used by the police in their war against the criminal.

In time—although how soon I should not care to predict—science will cause premeditated crime virtually to vanish from the earth by making the hazards of wrongdoing too formidable to challenge. We shall then have to deal only with crimes committed in sudden passion.

Self-Stabilizing Plane Lands in Small Space

Copy Holder Prevents Eye Strain

AN INGENIOUS copy holder for typists that combines several unusual features is the latest stenographic luxury offered by inventive science. An upright frame attached to the typewriter at the rear holds the copy. The latter is moved into view a line at a time by the action of the machine's spacing lever.

An electric light, from which the ultra-violet and infra-red rays that sometimes injure sensitive eyes are filtered, illuminates the line to be copied. The line is made still easier to read by a longitudinal lens that adjusts readily.

Above: The new eye - protecting copy holder. Harmful rays are filtered from the artificial light and a lens magnifies words and lines

Ash Dust Nuisance Ended by Sliding Can Top

THE householder who must serve as valet to his furnace all the winter undoubtedly will be interested in the device shown in the illustration above. It is an ash dust eliminator, which permits him to empty the ashpit without covering his clothes with dust and inhaling it.

The appliance is placed over the top of an ordinary ashcan. When a shovel of ashes is to be thrown in, a pedal lifts a sliding door. Withdrawal of the foot permits the door to fall back into place, thereby imprisoning the cloud of dust.

Asphalt Shingles Interlock

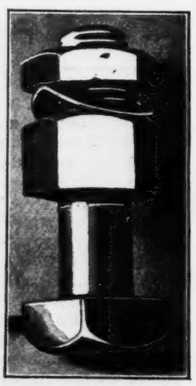
THESE workmen are covering a roof with the new hexagonal asphalt shingles that lock together on the roof. One corner of the shingle is doubled under and the double thickness is pierced by a galvanized metal strip projecting slightly beyond the edge of the shingle. This strip and the doubled portion hook into the space between the shingles, interlocking them.

Ingenious New Locknut

SHOWN here is a locknut for security where strains and vibration tend to loosen ordinary nuts.

The lower nut is screwed on the bolt, which has two opposite flat surfaces. A V-shaped spring washer slips on, its square central opening fitting the bolt's flat surfaces. The washer's two under faces have each a shoulder that engages the shoulders of the lower nut.

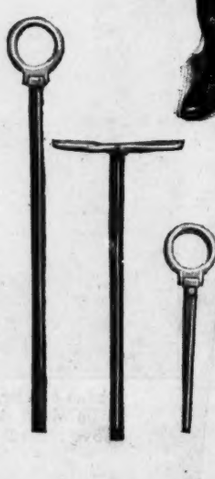
Another nut with notches in its lower face is screwed down against the washer. The washer's V points lock into the notches of the upper nut, thereby locking both the washer and the upper nut in place.



A Cane, a Saw, and a Seat Are Cleverly Combined

IT'S a cane, also a seat, likewise a saw. The handle of this versatile cane is in two sections, each of which can be swung in opposite directions to a horizontal position and clamped there. The cane is thus converted into a temporary seat or stool capable, it is said, of supporting 250 pounds.

The cane, in spite of its capacity for bearing weight, is hollow, and contains a narrow - bladed saw, which is made available by withdrawing the handle. See picture below.



It looks like a cane, but within a minute it can be converted into a seat or a small wood saw

Heater-Fan Stool Aids in Shoe Fitting

A switch controls heater and fan attached to stool

FOOT-EASE powder and the deft hands of the salesman are now supplemented by another important ingredient of shoe-purchasing comfort. The salesman's stool pictured herewith contains a small electric heater for cold or slushy days and a small electric fan for hot days.

The sense of comfort that induces a purchaser to accept a pair of shoes as her particular pair thus may be contributed to by obtaining the ideal foot temperature for fitting, says the inventor.

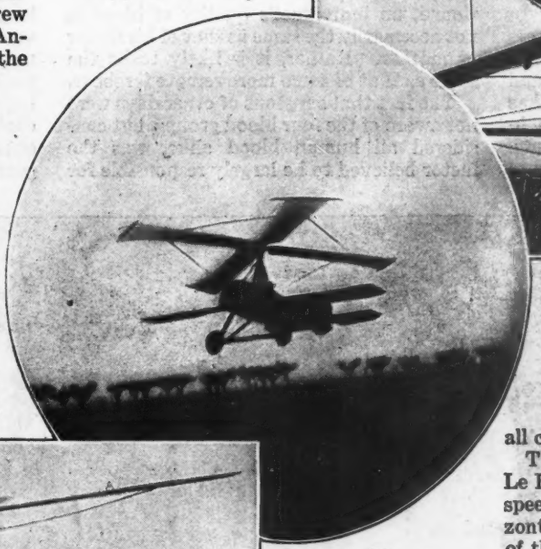
Self-Stabilizing Plane Lands in Small Space

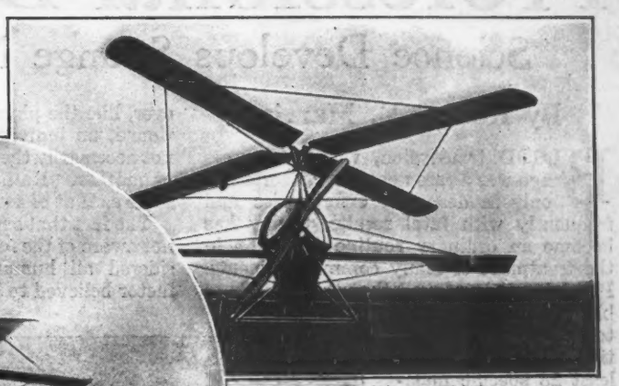
FROM long experiment and repeated failure, a Spanish inventor, Juan Lacierva, has developed a new type of airplane, the "autogiro." The name is derived from the self stabilization accomplished by a four-bladed horizontal screw turned by the wind produced in flight. Another remarkable ability claimed for the machine is that of landing with virtually no forward speed and within a few feet. It is said to fly successfully without lateral control, and locking the elevator controls affects the behavior of the machine in no way.

The machine is not a helicopter. In a helicopter the blades that seem to correspond to those shown above the Spanish machine are the actual propeller. In the "autogiro" this four-bladed screw is a sort of wind vane, not connected with the power plant.

The vane is not controlled by the pilot, but the blades are so arranged that they adjust themselves to the machine's motion and to the centrifugal force of their own rotation. This automatically insures stability under all conditions, even in making a turn.

Below: The "autogiro" in flight a minute after taking off





Above: Position and construction of the unique four-bladed stabilizing vane

Left: The remarkably light construction of this latest departure from established aeronautical design. Note the small wings made possible by screw stabilizer

The plane, driven by an 80-horsepower Le Rhône engine, is said to have attained a speed of from 40 to 55 miles an hour in horizontal flight. The velocity of the blades of the "autogyroscope" is greater than the forward speed of the machine at any time when in flight, the rapidly revolving screw acting both as a stabilizer and as a brake, giving a wide range of speeds and angles of flying. Its tendency to "brake" the machine permits the making of landings in limited spaces.

The "autogiro" weighs about 1100 pounds loaded.

Carbureter Uses Kerosene at Higher Engine Speeds

A TWIN-BOWL carbureter that supplies gasoline until the engine has been running long enough to use kerosene, whereupon it supplies only the latter, now is offered the car owner. It is the invention of a Miami, Fla., man.

The device much resembles the ordinary carbureter, except for its two bowls. These are connected with the intake manifold, which contains a two-way leaf valve actuated by the air taken through the manifold. The gasoline bowl is in position when the car starts. But when the air velocity through the two-way valve reaches approximately 200 feet a second, it causes the bowls to shift and kerosene to be fed to the motor. As kerosene cannot be used in throttling down, this action is reversed when the air velocity falls below 200 feet. The valve can be adjusted to a different air speed, so that a motorist gets full mileage from any fuel.

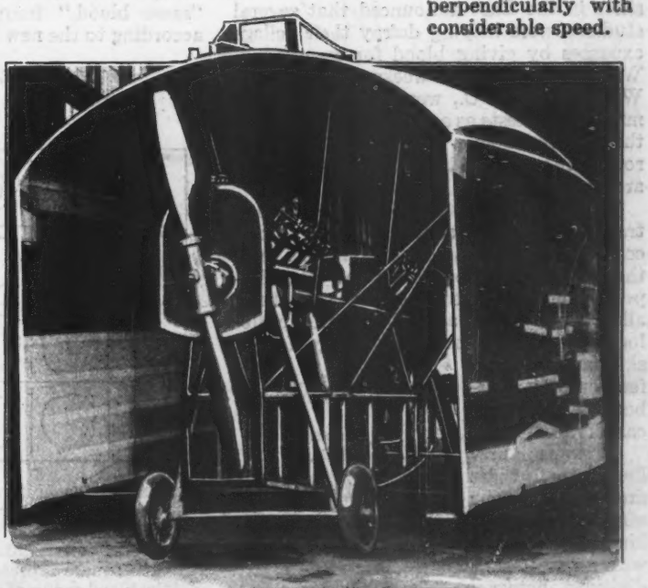
Helicopter to Try for $250,000 Prize

PERHAPS the most striking fault of the modern airplane is that it requires a large area for ascension and landing. In war, when fire, shell destruction, or engine trouble compel a flyer to descend, he frequently loses his life and his plane because the shell-pitted and wire-tangled terrain affords no safe landing.

Even the peacetime activities of aviation involve occasional necessity for quick descent. A plane carrying the governor of Oregon to California a year or so ago suffered serious engine trouble above the Siskiyou Mountains. Landing would have been involuntary suicide. Fortunately, the pilot accomplished a belated makeshift repair and outwitted the danger.

A helicopter — a flying machine capable of rising and descending perpendicularly — would virtually eliminate these hazards. Also it would permit more rapid ascension. The British Air Ministry, aroused to the need for such a device, some time ago offered a $250,000 prize for a completely practicable helicopter.

The machine illustrated here will contest for that prize. It is a 15-foot, U-shaped tunnel of wood, aluminum, and canvas inclosing the top and sides of a double motored lifting device equipped with twin propellers. The driving of wind under the canvas is expected to raise the helicopter perpendicularly with considerable speed.



The new Curtis V-2 tunnel type helicopter

The machine will be provided with two 200-horsepower airplane motors, each driving a 10-foot propeller.

The pilot sits between the motors.

Professional Donors of Blood

Science Develops Strange New Way of Earning a Living

By Robert E. Martin

BLOOD transfusion, which 10 years ago was a rare operation, resorted to only in desperate emergencies and frequently with fatal results, to-day has become an ordinary routine operation in the treatment of many common ailments. Physicians have found that the transfer of blood from one person to another is an effective treatment for at least 28 specific maladies, including typhoid fever, pneumonia, coal-gas poisoning, hemorrhage, infections, blood-poisoning, shock, and many debilitating conditions.

Danger Eliminated

New knowledge of the nature and methods of the operation now enables surgeons to perform it with no danger either to the person who gives the blood or to the patient who receives it. In fact, so common and so safe has the operation become that many persons are earning their living either wholly or in part as professional donors of blood. Attached to every large hospital is a group of 30 or 40 healthy men who are on call by telephone at every hour of the day and night, ready to hasten to the operating room and save a life by giving a blood transfusion.

The faculty of one of the largest universities in the East announced that several students were helping defray their college expenses by giving blood for transfusion. Within the last few weeks the police of Washington, D. C., were required to submit to blood tests as a means of determining their fitness to give blood in the operating room. Members of the fire department also are to be tested.

The development of the science of blood transfusion is due almost entirely to discoveries made by American surgeons since the beginning of the World War. Most important of these was the discovery that not all human blood is alike, but varies in biological qualities, just as coloring of hair, skin, and eyes differs among members of the Caucasian race.

Surgeons now know that there are at least four main classes or kinds of blood, with many subdivisions between each class. They know, too, that quality of blood is inherited, just as yellow hair and blue eyes may be inherited. However, like the physical characteristics mentioned, an individual's quality of blood is not necessarily the same as that of his father or mother. Rather, it is likely to be the same as that of some more remote forebear.

The fact that surgeons of other days were not aware of the four blood groups, but considered all human blood alike, was the factor believed to be largely responsible for the serious consequences that once followed many transfusions. A few years ago, when a transfusion was decided upon, a father, brother, or some other close relative would volunteer to give the blood needed by the patient. Although people near of kin always have been referred to as of the "same blood," frequently they are not, according to the new blood classification.

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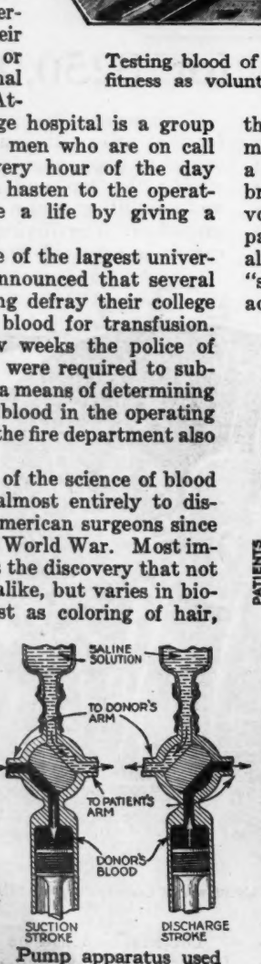
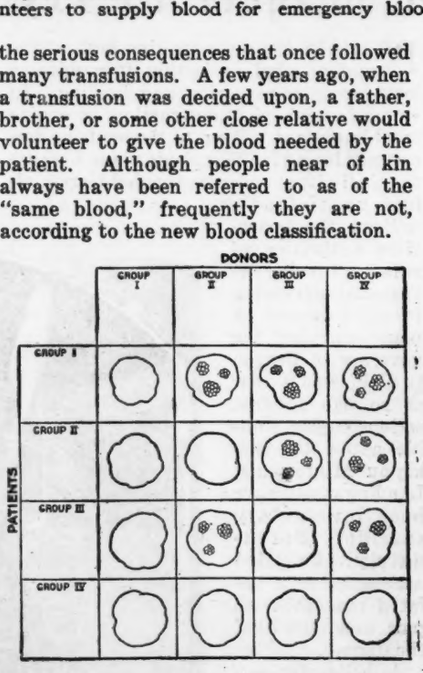
Testing blood of police officers at Washington, D. C., to determine their fitness as volunteers to supply blood for emergency blood transfusion



Pump apparatus used in blood transfusion. Salt solution prevents coagulation



This chart illustrates how the four different kinds, or groups, of human blood react upon one another in the process of transfusion. The figure in each square represents the reaction of the blood group of the donor upon that of the patient. Dark clusters indicate "agglutination," or the sticking together of blood corpuscles, which impedes blood circulation. Thus, blood corpuscles from Group I are agglutinated by blood serum of any other group, while Group IV corpuscles never are agglutinated by other groups

Moreover, if the blood of a person belonging to one group is introduced into the veins of a person belonging to another, it may cause the red blood corpuscles of the patient to "agglutinate"—that is, to stick together in large, compact masses that choke up the tiny capillary veins, impede circulation, and cause fever. Hence, surgeons now select as the giver of blood a person whose blood belongs to the same group as that of the patient.

The patient's blood classification is determined by mixing samples of his blood with serums prepared from the blood of persons whose "blood groups" are known. Usually, with professional blood-givers on hand, the surgeon selects several belonging to the same blood group as that of the patient and repeats the tests, mixing their blood and that of the patient under the microscope in order to be certain that, while they belong to the same group, they do not belong to certain subdivisions thereof. Through these tests, the surgeon is assured that he may attempt the operation safely.

Where once it was necessary to dissect an artery from the donor's arm and sew it to the patient's artery—a complicated process requiring a large incision—recent development of ingenious apparatus makes it possible now to perform a transfusion in which a pint of blood is exchanged in a few minutes and with no incisions larger than the injection of hypodermic needles into the veins of patient and donor. Neither suffers pain, inconvenience, or shock.

Although professional donors are being used more and more, recent investigations indicate that better results are obtained by using the blood of a relative or friend of the patient, provided a person in the proper group will volunteer. A healthy man, surgeons say, is not harmed by the loss of a pint of blood; but six transfusions a year are about as many as the strongest person can stand. In consequence, surgeons endeavor to prevent blood donors from making their "profession" too profitable by submitting to transfusion too frequently. Those who elude the vigilance of the surgeons and give blood oftener than is advised, lose vitality, become feeble and pale, and their blood under test is found to be thinner and weaker than that of the patient.

Medical men believe that the scope of usefulness eventually will be extended beyond the treatment of the 28 maladies for which blood transfusion now is being employed. In the meantime, the operation has been made safe and comparatively simple; safe for the patient if proper tests are made before the selection of the blood donor, and safe for the donor if he does not attempt to submit to the operation more often than the surgeons advise.

would be considered, of course, merely another variety of the "shining stuff," the

artisan would try, naturally, to shape it more exactly by the same method he used on his crude flints, that is by pounding it.

About 1500 or 1200 B.C., iron tools and weapons began to appear. The Aryan invaders who came down from the north into

Conquerors of Metal and Coal

Ninth Article in "The Story of Man and His World"

By E. E. Free, Ph.D.

MOST of us live, really, not on meats and vegetables, but on coal and also on iron.

By the mastery of these two materials, which has given us, in turn, tools and machines, man has been able to multiply the food supply of the world perhaps a thousand times.

We get our food nowadays, not so much from the mere natural productivity of the soil, as by the help of the metal that is the backbone of our civilization and of the black mineral that drives most of the machinery of the world.

Coal and Iron Mean Life

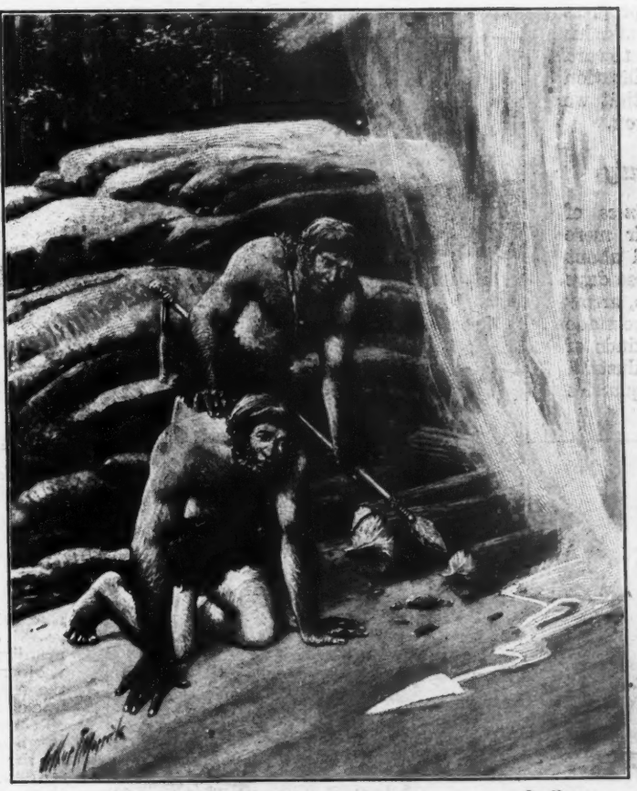
If some magic power were to remove suddenly from the world all of our iron and coal, as well as the oil, our newest substitute (in part) for coal, nine tenths of the population would vanish in less than one generation.

Without iron tools the farmer could not maintain the yields of foodstuffs from his acres. Without coal to make steam and run our railways and steamships we could not move even what food there was to the places where people were waiting to eat it.

The vital importance that these material things—coal and iron and oil—have come to have in the world of living matter is another instance of the fact that I have emphasized so many times in this series of articles—the fact that evolution is not all over and done with, but is going on in the world every instant, right here and now.

The story of evolution did not stop with the perfection of man's body or with the discovery of civilization or of speech. One of the main scenes of this story, a scene as significant as any of them for the future of man and his world, is that which shows the gradual conquest of materials like the metals and of power like that we get from coal. Today, right under our eyes, there is going on this conquest of the world by man, a conquest for which the long history of man's bodily evolution was merely the preparation.

The first step in the progress that has given us, in the end, our mastery of coal and iron, was the discovery of the first metal. This happened long before the beginnings of written history, but something of how it came about we can read from the relics that have come down to us, from the gold beads and bits of copper and fragments of iron tools that scientists have dug out of the discarded rubbish of the ancient villages.



A turning point of life. How the ancient caveman, finding a spear-shaped piece of copper in his fire, may have discovered the use of copper, thus beginning the long progress from barbarism toward the modern Age of Metals

The first metal known to man was undoubtedly gold. This fact is easily explainable. An ape-man bending down over the water, intent to clutch a fish, or a thirsty cave dweller braving daylight to gulp a drink, saw shining on the stream bed the little glittering lumps that seemed beautiful enough to be alive. Once in a while he took some of them home with him; some were the clear crystal pebbles that we call gems, some were the heavy yellow lumps of gold. Thus began the gathering of treasure.

Our World Built on Beauty

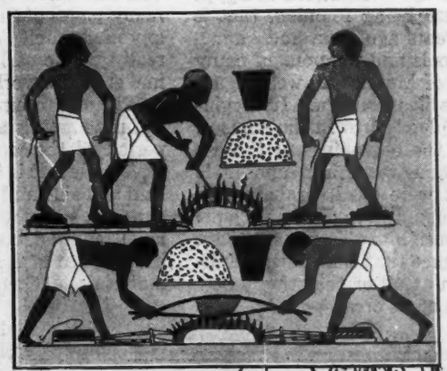
It is significant that this finding and keeping of gold, which was the first step toward coal and iron, was, at bottom, a response to beauty. The ape-men gathered gold, not because they *needed* it, but because they *liked* it. This is an answer for you to give the materialist when he tells you that beauty is of no use in the world. Say to him that the material civilization of which he is so proud, the coal-iron basis of all our boasted wealth and artistry, began, literally, with the attempt of ancient men to carry home a little bit of beauty.

The second and less important step toward coal and iron was the discovery of silver. Like gold, it was first gathered because it was shiny. It, too, occurs in the rocks as the free metal.

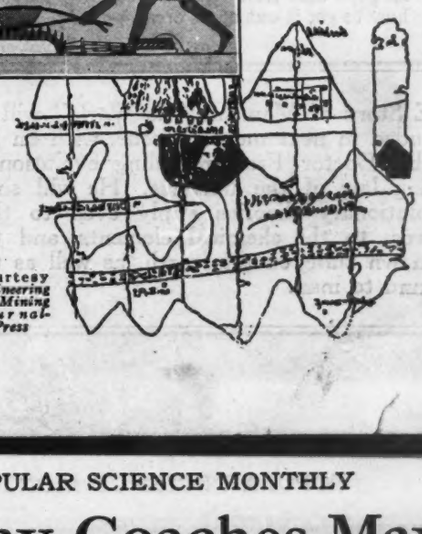
But though gold and silver were the beginnings of this material conquest, they were not themselves its instruments. So far as we know, no man ever made tools of them. They were ornaments, treasures, objects of art in ancient times, just as they are today. The first *useful* metal was copper.

The most ancient copper objects found are about 10,000 years old.

They were recovered from the lowest strata of the ancient village site at Anau in Western Asia, which is about the locality, if you remember our chapter on the men who invented civilization, where human society first began. These earliest known copper objects are beads and little plates and rods. It is unlikely that they could have had any use. Probably they were merely ornaments and treasures.



How the ancient Egyptians smelted metals with foot bellows (at left). The bellows were filled by raising the foot and simultaneously pulling the string. Then foot pressure forced air into the fire



The most ancient mine map in the world (at right). Drawn by ancient Egyptians on a piece of papyrus, it shows a gold mine that was worked more than forty centuries ago

Courtesy *Engineering and Mining Journal-Press*

Drama around Primitive Fires

But how did men come to have them? Copper nuggets are not found loose in streams. We cannot believe that primitive men acquired all at once, by inspiration, the skill to get the metal from its ore.

The most plausible suggestion is made by the distinguished English archeologist, Lord Avebury. It may have happened, he says, that primitive men, when they built fires for cooking, accidentally got into the fire some chunks of rock that contained copper. The heat would melt out this copper. Later on, some curious individual, hunting through the ashes, would find the little metal beads. Such copper beads

Luxurious Railway Coaches May Take Wing

would be considered, of course, merely another variety of the "shining stuff," the gold and silver.

If we may judge from the remains of Anau, it was some centuries, perhaps as much as 1000 or 1200 years, before anybody made the next important discovery about metals—the discovery that copper could be used to make tools.

This discovery, when it came, was another of the turning points in the progress of life. Henceforth man was to make his own materials. His face was set toward the mechanical, power-using civilization of the present, the civilization that we have called the Age of Coal and Iron.

Men Find a Use for Beauty

This discovery of the *usefulness* of metals, as contrasted with their mere beauty, seems to have happened about 8000 or 10,000 years ago. In those days the tools of men, their spearheads, arrow points, needles, and fishhooks, were made either of flint or of the harder kinds of bone, such as ivory. The chief industrial material was stone. Men had quarries here and there over the world where a good quality of stone was to be obtained. From these quarries the crude flints or the implements manufactured from them by skilled workmen were carried by a sort of rude commerce all over the neighboring parts of the world.

Now this established use and commerce in flints was a very important preliminary to the use of copper. Men knew all about flint tools. The spear or knife of well worked stone was as familiar a thing then as a pocket knife is now. And it is a very significant fact that the first spears and knives of copper *copy exactly the shapes of the earlier ones of stone.*

The meaning of this is clear. The first man who made a copper spearhead made it to resemble a stone spearhead. But what made him think that he could do this?

Learning How to Shape Copper

Here again we must imagine, I think, the occurrence of a happy accident. Some day a potter or a hunter making ready to cook his food, built a fire more than usually large and hot. There was copper in it, too. The copper melted out as usual, but instead of making merely beads among the ashes, there was enough of the metal to run out in a stream and make a thin plate-like form that may have looked like a spearhead, knife, or some other implement already familiar among the various tools of stone.

The cavemen, if not intelligent, were observant. A metal shape like a spear would not fail to be noticed. From this it was a natural step to *trying* it as a spearhead. Being tougher and less breakable than stone, the new copper shape would disclose at once its practical value. The active-minded artisan would try, naturally, to shape it more exactly by the same method he used on his crude flints, that is by pounding it. In this fashion, then, men may have come upon the knowledge of how to get copper out of the rocks and of how to hammer it into useful shapes.

The next steps toward the Age of Coal and Iron were easy. The regular manufacture of copper from its ores, the making of stronger and sharper implements from it, the discovery of the harder natural alloys of copper and tin that we call bronze; all were simple and inevitable developments from the first discovery of copper and of its use. By the time the civilizations of Egypt and Babylon were being founded, that is by about 6000 years ago, men had knowledge of copper tools and weapons of many kinds. The Age of Metals was well begun.

But iron was still unknown. Its beginnings are as completely lost in the mists of antiquity as are the beginnings of the use of copper. Ornaments of iron and little pieces of it that were used, probably, as magic stones were known in ancient Egypt. They may have been bits of iron meteorites. There is no evidence that the ancient civilizations *used* iron at all or that they knew how to get it out of its ores.

These pictures show vividly the growth of modern metallurgy. The photograph shows the removal of a whole mountain of copper ore at Bingham, Utah. At the left is a modern steel plant, producing more iron in a minute than the primitive blacksmith could have pounded out in his whole lifetime

About 1500 or 1200 B.C., iron tools and weapons began to appear. The Aryan invaders who came down from the north into Greece and began the great Grecian civilization knew all about iron and used it freely. Lumps of iron were the highest prizes in the earliest Olympic games.

Where and how these men learned to make iron we do not know. It was a natural outgrowth, probably, of the previous industry of working copper. Men of inventive mind among the coppersmiths tried other sorts of rocks as sources of the red metal. Somewhere, by accident, somebody tried an ore of iron. With the charcoal of the wood fire the ore produced the metal, in exactly the same fashion, indeed, in which the so-called "Swedish" or "charcoal" iron was made in many parts of the world down to recent times.

Early Iron Workers

The primitive iron, of course, was not very pure. It was obtained in little buttons or lumps. These had to be purified by heating and pounding on an anvil and gradually worked together into fragments large enough to make a tool. The art was much more difficult than the art of working copper. The men who mastered it were important men in the community, so important that they took, with proper pride of accomplishment, the name of their trade for the name of themselves.

They were the first of the Smiths; called originally the "smiters," that is, the men who knew how to pound out the iron. The many pages of Smiths that you will find in any modern city directory are a monument really to the early importance of the iron-maker in the world.

With the taming of iron we have reached, so far as metals are concerned, the modern period of the world. Following centuries have added, it is true, several new metals—lead and zinc and nickel, and the still newer ones, such as aluminum and tungsten. We have acquired, too, a kind of artificial stone in the form of cement and many accessory materials such as glass and paper. But the essentials of the modern use of materials had been achieved when one prehistoric genius had copied his stone ax in copper and another one had copied the copper ax in iron.

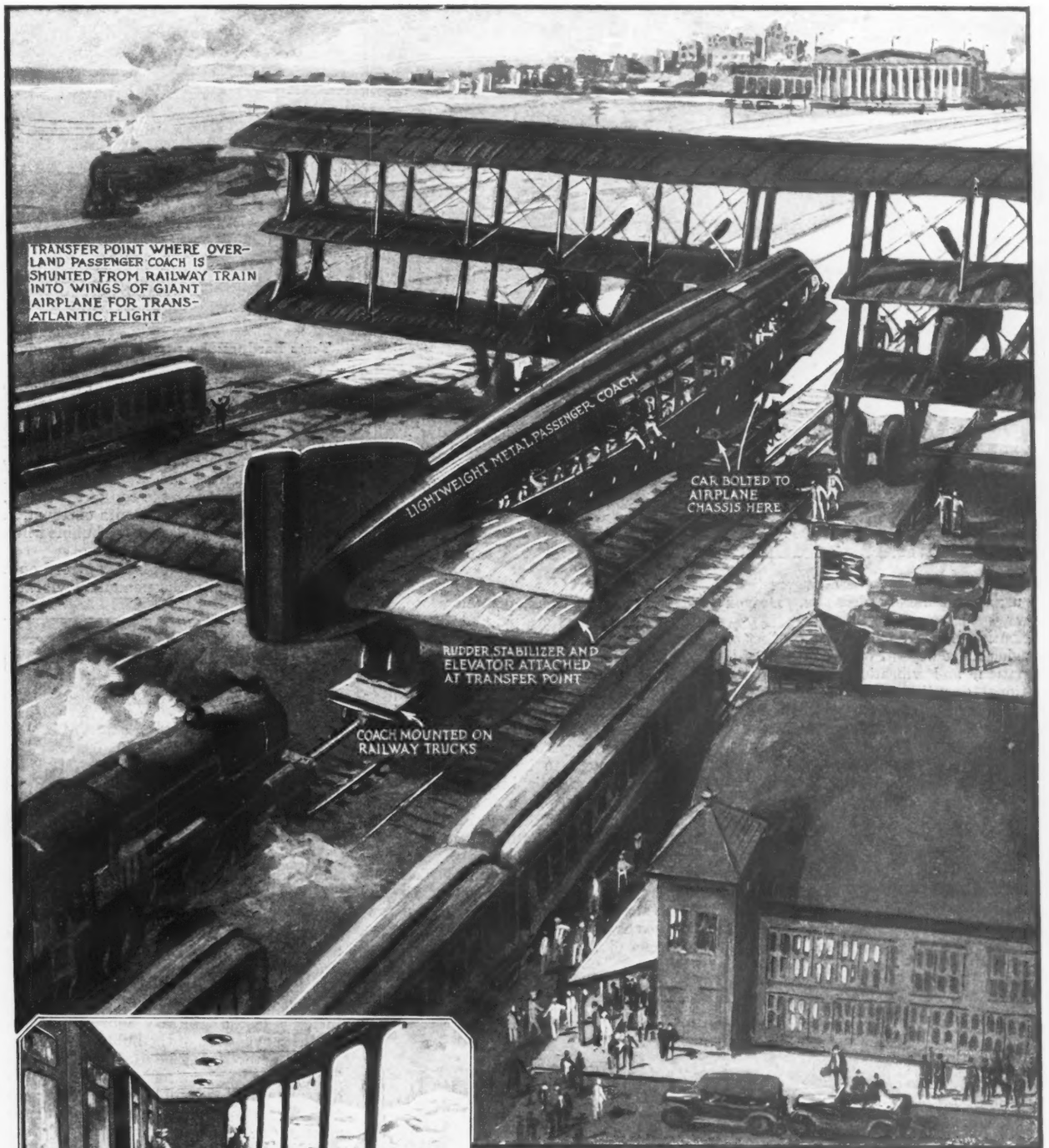
This had happened about 3000 years ago. Man had reached what historians call the Iron Age; but not that greater age—the Coal-Iron one. There was one more step, the conquest of mechanical power, of steam, and of coal.

(*Turn to page 141*)

"THE Story of Man and His World" will be concluded in next month's issue, with an inspiring article by Doctor Free, revealing evolution as the compelling law of the universe. He will show how the evolutionary theories apply even to the stars themselves, to the chemical elements, and to every other known thing on this earth, as well as to living matter and to man.

New Instrument to Test

Luxurious Railway Coaches May Take Wing


TRANSFER POINT WHERE OVER-LAND PASSENGER COACH IS SHUNTED FROM RAILWAY TRAIN INTO WINGS OF GIANT AIRPLANE FOR TRANS-ATLANTIC FLIGHT
LIGHTWEIGHT METAL PASSENGER COACH
CAR BOLTED TO AIRPLANE CHASSIS HERE
RUDDER STABILIZER AND ELEVATOR ATTACHED AT TRANSFER POINT
COACH MOUNTED ON RAILWAY TRUCKS

Above is shown the proposed transfer point where land-and-air passenger cars would be shunted from a transcontinental train into the wings of a giant airplane. At the left, a luxurious observation deck of the contemplated passenger car

IS A round-the-world journey—overland by rail and across oceans by plane, without changing cars—to be an aeronautical commonplace of tomorrow?

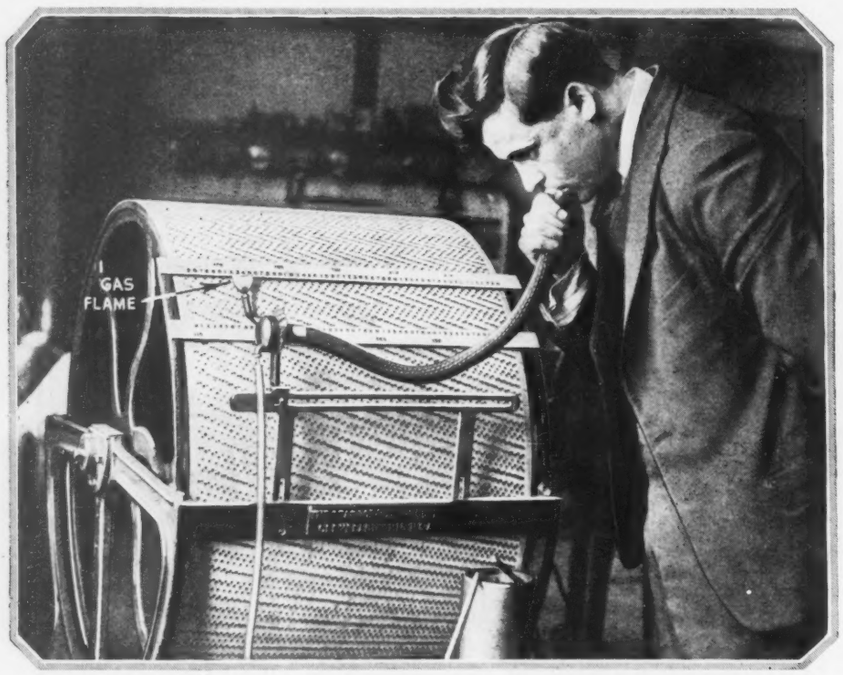
Late advices from England indicate that British engineers and inventors are approaching success in just such an adventure into super-transportation.

The project contemplates great passenger compartment cars to be transported either on railway trucks or attached to huge airplane wings. Transcontinental trains, arriving at an airdrome transfer point, would shunt these land-and-air cars into the wings of a giant airplane. Thus, without waking in their sleeping accommodations, passengers would be racing on rails down the Hudson valley one hour, and on wings above the Atlantic the next. No time would be lost in rail and steamer connections, and rail economy would be combined with the tremendous speed of man-made wings.

The fascinating possibilities of such a scientific stride incite the imagination. We may foresee luxuriously appointed passenger cars, equipped to furnish entertainment and comfort to passengers. We may imagine ourselves as these passengers, one morning enjoying an Ohio landscape from the car windows; on the evening of the next day looking down upon the conquered Alps.

Engineers of the Pullman Company for several years have been studying the possibilities of aerial pullmans, and will be ready to construct them the moment aeronautical advance makes them feasible.

Inventive Science Brings Comfort to the Sick



Voice analysis by observing a dot-covered revolving drum through a fluctuating flame

Voices Made Visible and Analyzed by Science

THE voices of some opera singers thrill us; others merely please us. Do you know why?

Scientists have known that the effect of a singing voice depends on two qualities—intonation, and vibration, involving the emotional qualities of the tone. But it remained for Dr. Max Schoen, of the Department of Psychology, Carnegie Institute of Technology, to explain why intonation so largely affects voice quality.

By careful analysis Doctor Schoen concluded that we can trace many of our likes and dislikes of singing voices to the manner in which the singer attacks, sustains, and releases each tone, or progresses from one tone to another. To demonstrate this theory, he developed a phonograph attachment to the tonoscope (shown above)—a delicate tone-analyzing instrument that produces a picture of tone vibrations.

The tonoscope consists of a large motor-drive revolving drum, painted white. On the white surface are painted 18,095 dots arranged in 100 rows. The first row has 110 dots, the third 111, and each succeeding alternate row one additional.

These dots are observed through a fluctuating gas flame that can be moved from row to row as the experimenter seeks the pitch of the singer's voice. The flame is caused to fluctuate by vibrations of the singer's voice on a diaphragm.

As the drum revolves at one revolution a second, the dots become blurred. The row behind the fluctuating flame, however, is seen to move up and down with a jerky motion. When a vocal tone strikes the diaphragm, the experimenter moves the flame along the rows until he finds a row that seems to stand still. A scale indicates the exact pitch of the tone.

World's Strongest X-Ray May Vanquish Cancer

ATTACKING the still unconquered scourge of cancer with what is said to be the world's most powerful X-ray, Dr. Lewis Friedman, noted radiologist and cancer specialist, holds forth hope.

He announced recently that in a case far advanced, he had reduced one dimension of an internal abdominal cancer three quarters of an inch, using the phenomenal voltage of 250,000.

Doctor Friedman asserts that the rays from his machine are identical with some radium rays.

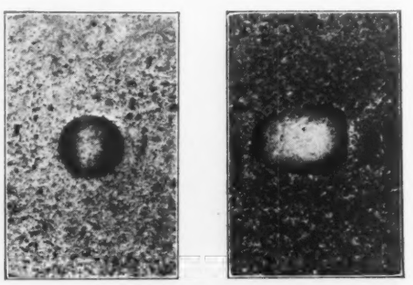
Dr. Lewis Friedman, cancer specialist, attacking the scourge with a 250,000-volt X-ray. He is hopeful of effecting cures

New Instrument to Test Hardest Materials

Tests hardness by pendulum oscillations

AN INGENIOUS instrument for testing the hardness of materials has recently been developed in England. It consists of a frame, supported by a ruby or steel ball, which, when placed on the material to be tested, oscillates like a pendulum. A curved spirit level at the top of the frame, supplied with a scale, permits observation of the distance traveled by the bubble when the frame oscillates.

When the supporting ball is placed on a very hard surface, the pendulum vibrates



Left: Impression made by pendulum merely placed on the material. Right: After the pendulum has been stopped by hardness

through a great distance and for a considerable time. Placed on a soft substance—lead, for example—there is no oscillation at all. This furnishes an index as to the relative hardness of materials which is recorded in terms of the arbitrary figures furnished by the movements of the bubbles.

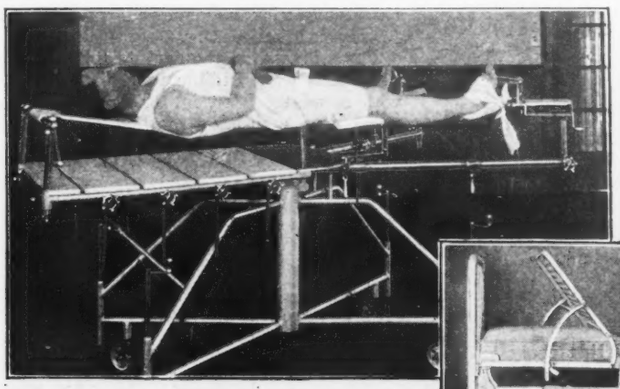
Two methods may be used for determining the hardness of a metal—observing the distance that the bubble moves from zero with the first oscillation of the pendulum or ascertaining the period required by the pendulum to swing 10 times.

Claims Birthmarks Vanish under Radium Rays

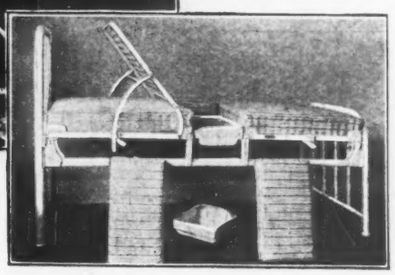
BIRTHMARKS, even the dark red "strawberry" blotches, which disfigure so many faces, are said now to be eradicable through the potency of radium. At a recent meeting of the American Radiological Society, Dr. Lawrence R. Taussig, of the University of California, announced the successful use of radium rays in destroying a variety of birthmarks. He declared that no great time was required and that the eradication was not painful.

Dr. Lars Edling, Swedish radiologist, rendered tribute to the astounding progress made by America in radiology.

Inventive Science Brings Comfort to the Sick



Left: An operating and fracture table that gives the doctor complete access to the body, yet is comfortable and free from strains to vital bodily parts



Above: An aerating bed that cools the body and prevents bed sores. Right: A vaporizer that uses an ordinary electric light socket

THE inventive genius of curative science recently has created the three devices here illustrated.

The operating and fracture table supports the patient on a long, soft hammock from head to lower back in such a way that he is accessible for plaster from the top of his head to the base of his toes. Moreover, he rests upon a soft support that conforms to his body outline, prevents pressure and permits him to maintain a position that is practically that of a person lying in bed.

Croup kettles, steam atomizers, inhalers, etc., it is claimed, have been made obsolete by this recently patented vaporizer. Wicks convey the liquid to be vaporized along the heated surface of a light bulb. A gauze screen about the device filters the vapor, keeping it fine and moist. The whole is attached to a light socket.

The third invention aerates the body for coolness and prevention of bed sores. A specially designed spring and a mattress made in four sections permit the pulling out of slides to create air currents about the body.

The two central parts of the mattress can be removed and a basin inserted in the opening. A back rest can be applied.

New Industrial Gas Mask Gives Greater Comfort

THE gas mask, which became so crucial a factor in the closing years of the Great War, has found a vital place in industry, and many ingenious improvements have been developed by the needs of peace. The latest development is this manifold hose mask used in oil refinery chambers.

It has neither mouthpiece nor nose clip, yet fits the face with perfect comfort and is airtight. Although, if special conditions require it, the usual filtering canister can be employed with this mask to use inside air, ordinarily the blower in the trunk shown supplies outside air from a distance. This blower can supply six masks at once.

Pressing Bills Are Reduced by Leg Raincoats

WHAT man has not taken to the presser's a pair of trousers neatly pressed above the line where his overcoat or raincoat started doing its duty and hopelessly shapeless below that point?

Rain did this to a Kansas City inventor once too often. He retaliated by devising and patenting leggings of waterproof material, supported in position by adjustable telescopic supporters that engaged over the stiff edges of the wearer's shoes. These leggings shelter the normally exposed area and pare off excess presser's bills from the vaulting cost of living.

Surprises for the Burglar Wait behind This Door

IT WOULD be a determined burglar who persisted in trying to enter this door. His first discovery would be that a stout chain prevented it from being opened more than slightly. His next discovery would be that in opening the door thus slightly he was sounding a bell, a bell that did not stop when his startled hand jerked away.

The bell operates without wires or batteries, being wound by hand when the bolt is set and spring-released by pressure.

Polluted Oysters Cleaned

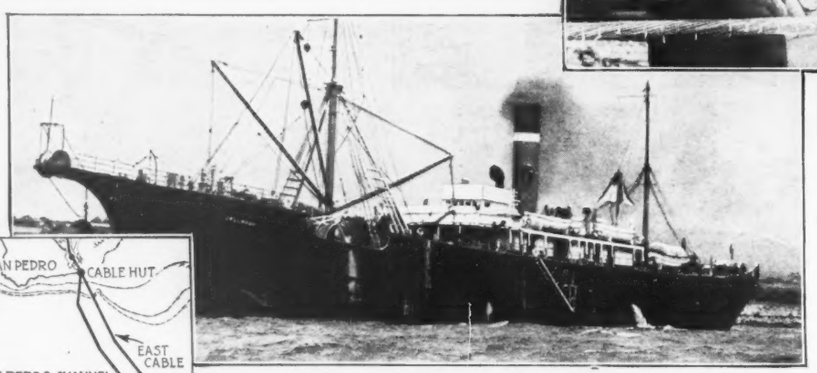
A COMMERCIALLY feasible method for making oysters grown in polluted waters safely edible was announced recently by the Conservation Commission of New York. The mollusks are placed in three successive basins of chlorinated water, wherein they wash themselves clean. This process is claimed to be more effective than any method short of complete sterilization.

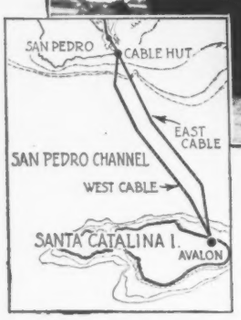
Cable Supplants Pioneer Radiotelephone

THE famous "talk bridge" between Avalon, Catalina Island, and San Pedro, Calif., the world's first commercially successful radiotelephone circuit, is being dismantled. Two telephone cables, each 27 miles long, accommodating seven simultaneous conversations, will replace it. The change resulted from the necessity for making possible more than one conversation at a time and from the request of the government that the station surrender its wave length for use in broadcasting.

The cable coiling force at work in one of the great cable tanks aboard the *Dellwood*. Fifty-four miles of the cable were coiled and uncoiled

Below, two welders, protected by masks splicing armor wires with an electric arc





Above: The army cable ship *Dellwood*

Left: Map of the route the cables traverse

For a long time the radiotelephone conversations were audible to every amateur who cared to listen in. Telephone engineers then devised a method of "scrambling" messages so that they were audible only to a receiving set specially designed and manipulated.

The new cables are composited to provide a duplex telegraph channel also. A copper sheath, concentric with the central conductor, is used for a return path. The multiple telephony possible over the single central wire is accomplished by a system of varied frequencies, analogous to those used in radiotelephony.

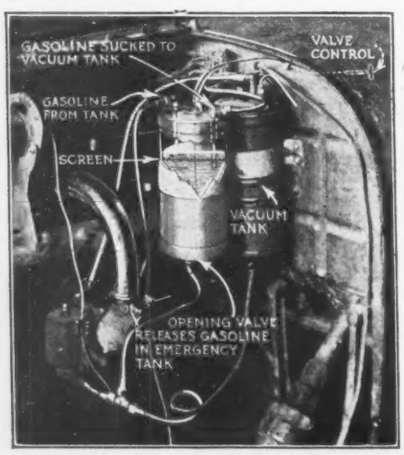
Each of the two cables includes sections of four different types, each designed for a certain range of water depth. They differ in size of armor wire, jute coverings, and other protecting sheaths, but not in the size of copper conductors. The shore ends are the most heavily armored sections.

Vacuum Tank Is Kept Clean by New Filter Box

NO DIRT, sediment, or water can go into your car's vacuum tank, it is claimed, if you install this emergency gasoline tank.

All gasoline used is sucked into it through the main gasoline line and filtered through a copper screen. The gasoline then is picked up by suction, flowing through a pipe to the vacuum tank.

One gallon of filtered gasoline always is available in this emergency tank. Pulling a choke on the dash starts it to the carbureter. Pushing choke back refills tank.



Vacuum tank and gasoline kept clean

Navigation Easier with New Rudder

USING a principle that earlier he had applied successfully to the steering of airplanes, a German inventor has devised an auxiliary rudder for ships that is said to obviate the necessity for a steering engine.

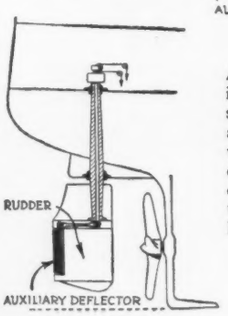
It is claimed also to keep the vessel on a straighter course.

The device is really an extra rudder, which performs the same function with regard to the main rudder as the main rudder does with regard to the ship. Its movements are controlled not by the helmsman but by the flow of water past it. It hangs free to swing about a vertical axis and when deflected, say by a wave, causes the main rudder to be similarly deflected, nullifying sudden shocks and jerks. Previously these required a steering engine of several hundred horsepower, which placed a tremendous strain on the steering apparatus and on the hull.

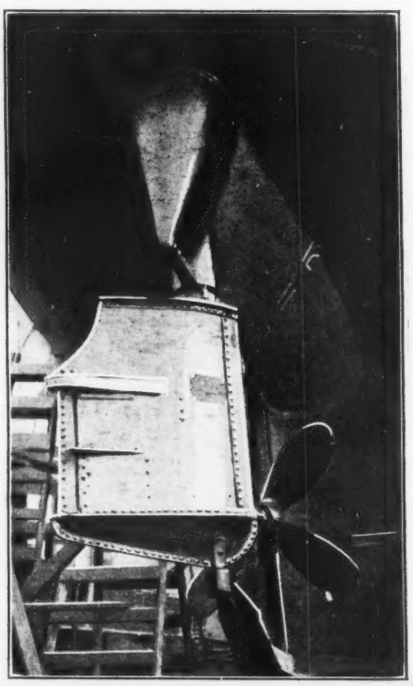
When the change in water flow ceases, an ingenious mechanism returns the rudder to its original position, the ship going back to its course much more quickly and comfortably than a steersman could send it back with the wheel.

The device has been installed on several large ocean liners and is said to have been operated with entire success.

The auxiliary rudder principle originally was applied by the inventor to air navigation, with marked success



A sudden wave in a storm will shift the auxiliary deflector, which in turn deflects the rudder similarly, thus largely nullifying the effect of the wave

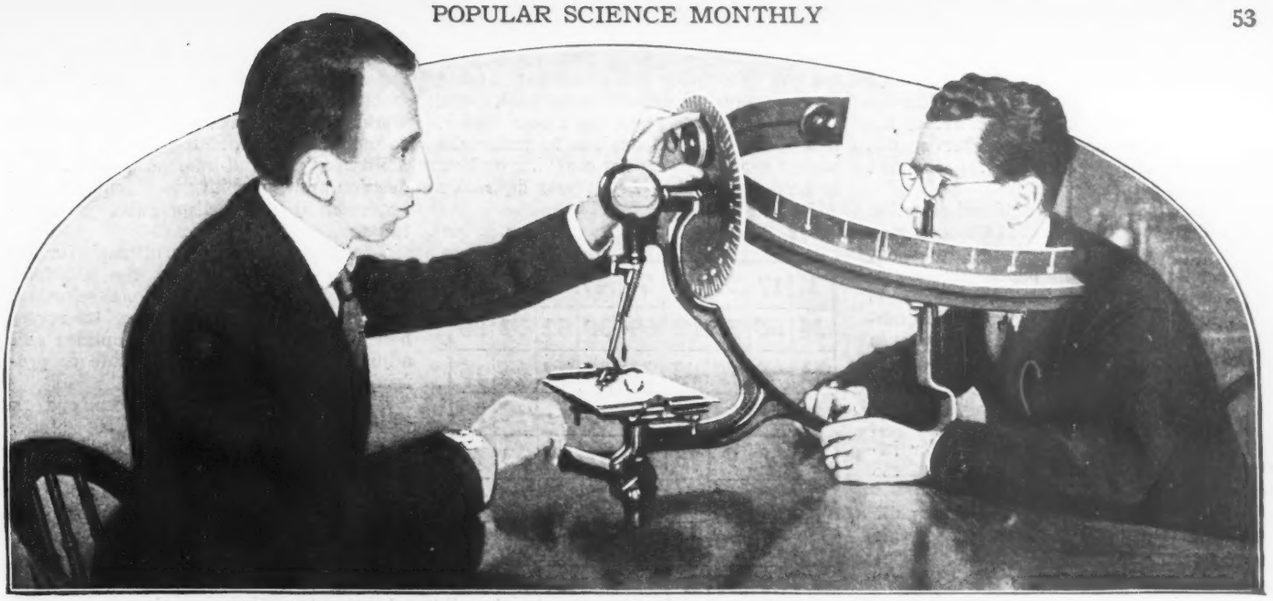


A close-up of the new auxiliary rudder installation on a passenger ship

days every week and during the whole summer, usually know nothing of the long

serve or cannot recall, you are a poor reader. The poor reader cannot succeed

General selling ability: Showing capacity for success in dealing with *people*. This is



The color perimeter, which determines your field of vision and zones of color perception

Are You in the Right Job?

By Herbert A. Toops, Ph.D.

Research Associate, Institute of Educational Research, Columbia University

GETTING the right job has been a vexing problem to most of mankind since the birth of civilization.

Prehistoric man found his job laid out for him at birth, for he was entirely dependent upon his unaided, personal efforts in wresting his food, shelter, and clothing from nature, from wild beasts, and from other men. If he failed, he died.

But the "square peg in the round hole," the "rolling stone," the "jack of all trades," the men who never quite find that particular vocation for which their capacities fit them—all of these we have had with us since men first left their solitary caves and camps, settled in communities, and made specialized division of their work.

But the man in the wrong job need remain a problem no longer. Science has hit upon ways of determining the right job, or at least of making it possible for a man to avoid wasting time and effort on a job in which he is bound to fail.

This new science may be called "vocation selection." It is exact. It is comprehensive, and it is so elastic that, once its principles are explained, almost any man of average intelligence may readily adapt them to test the aptitude of any one for any trade or profession.

It is based on the theory that the principal cause of vocational misfits and consequent failures is the haphazard, headlong way in which men rush into a line of work without first determining their intellectual fitness for it. No man of meager physique and frail strength would think of embracing such a career as blacksmithing, say, or lumbering. Yet men without number whose intellectual equipment is average or less, seek to succeed in professions and occupations that require general intelligence of the highest sort or intellectual qualities of an extremely special sort. Again, men of high intelligence often undertake work whose simple intellectual demands never can engage their hearty interest.

Early attempts to find for a man the job that suited him went not much further than inquiring what profession or trade interested him. This was better than forcing him into some distasteful occupation, but the limitations of such vocational selection are apparent. Many persons nowadays are interested in radio and automobiles and moving pictures. That obviously does not indicate that they should all be radio engineers, automobile manufacturers, or moving picture producers.

Personal inclination is often superficial and hence an inaccurate and even a dangerous index. Dislike may be expressed for work that would be enjoyed if tried.

Many persons express a liking for such professions as banking and teaching. Pressed to explain their preference, if they are honest, they often will admit that they prefer banking because bankers usually appear to be prosperous and because their hours of work are from 10 to three. Their preference for the teaching profession also usually is founded upon some similar reason—often a misconception. For those who would be bankers because of the short hours of business, or teachers because the schools are closed two

Is Your Job Big Enough?

ARE you wasting yourself in a job that does not use the best in you? "Four of every five men," says William J. Kibby, famous business psychologist and employment expert, "never find that work for which they are particularly fitted."

Such men offer their employers only those capacities that thousands have. They never use and never are paid for their valuable, often unsuspected, special aptitudes.

Ruts are hopeless only when not seen by those in them. If you feel that somewhere is a job in which you could be happier and more efficient, whet your mind on the tests Doctor Toops offers you here.

Read this inspiring article on how Science helps the man who has not found his right niche in the business world.

Here's a Way to Test Your Clerical Ability

Af ( )	Jg ( )	If ( )
Bc ( )	Ig ( )	Ge ( )
Jd ( )	Ie ( )	Dc ( )
Bi ( )	Fg ( )	Eh ( )
Ii ( )	Di ( )	Aj ( )
Jf ( )	Cg ( )	Ih ( )
Df ( )	Hj ( )	Jj ( )
Ej ( )	Bj ( )	Dg ( )
Ji ( )	Fj ( )	Jh ( )
Ch ( )	Dh ( )	Gg ( )
Ai ( )	Hi ( )	Cf ( )
Fj ( )	Ci ( )	Bh ( )

OPPOSITE each of the combinations of letters above mark the number appearing in the corresponding row and column of the chart at the right. Thus, the number for Af is 6.

Work exactly three minutes. If you can mark down 25 numbers correctly in that time, your score is "excellent." From 15 to 24 numbers in that time gives a rating of "average." Less than 15 marked down in three minutes gives a rating of "poor"

	a	b	c	d	e	f	g	h	i	j
A	1	2	3	4	5	6	7	8	9	10
B	11	12	13	14	15	16	17	18	19	20
C	21	22	23	24	25	26	27	28	29	30
D	31	32	33	34	35	36	37	38	39	40
E	41	42	43	44	45	46	47	48	49	50
F	51	52	53	54	55	56	57	58	59	60
G	61	62	63	64	65	66	67	68	69	70
H	71	72	73	74	75	76	77	78	79	80
I	81	82	83	84	85	86	87	88	89	90
J	91	92	93	94	95	96	97	98	99	100

days every week and during the whole summer, usually know nothing of the long hours that bank employees labor after the doors are closed to the public, nor of the nights and holidays the teacher spends correcting papers, compiling reports, and attending to other details.

The new science of vocational selection is based on the principle that if a man says he is interested in a certain profession, whether he has had any experience at it or not, certainly he must have looked into it enough to be able to answer simple questions regarding it. If he can, he proves his interest to be more than superficial.

A Typical Carpenter's Test

If he is considering carpentry, for instance, a set of simple questions like these will test his interest:

1. What tool do you use to drive a nail?
2. What long tool do you use to smooth a rough board?
3. What size hole will a No. 8 auger bit make?
4. What does a "7" on a saw mean?
5. What tool is used to turn a bit in boring a hole?
6. What is the common name for a 20-penny nail?
7. What tool do you use to drive a chisel?

But the amount of general intelligence one possesses determines more than any other single characteristic or any knowledge about a specific thing, what shall be his achievement in life. It is important that one should know whether he is above the average, about the average, or below the average of his fellows in intelligence. Vocational selection furnishes an exact index to the general intelligence of an individual by psychological tests, of which two are illustrated in this article.

The test on page 53 determines aptitude for clerical work, for revealing natural speed and accuracy in handling figures, lines, and letters. The test on this page is an intelligence test to measure the keenness and adaptability of your mind.

But no one should consider that the results of a few tests are conclusive. At the very least a dozen, of varied types, should be taken before one can be reasonably certain that the results represent fairly your mind's capacity. Every corner of the mind must be probed if all its resources are to be revealed.

A reading test is important in indicating academic capacity or ability to progress in any work requiring quick understanding of the written page, in the study of law, engineering, or journalism, for example.

Get an encyclopedia. Select a paragraph at random and read it once. Then have some one read the same paragraph two or three times. Have him ask you questions about it. If he asks you regarding many facts that you did not observe or cannot recall, you are a poor reader. The poor reader cannot succeed in any profession depending on book work.

If the test shows you are a poor reader, and if you are still anxious to undertake such a career, get special coaching on how to read and study. *Learn your difficulties and then start to overcome them.* Textbooks on how to read and how to study can be obtained at any public library.

How to Test Concentration

1	17	25	41	7	47	22	50	3
36	60	73	12	69	30	62	53	80
23	48	79	65	78	76	72	46	16
61	77	40	32	2	56	42	24	37
68	51	9	75	15	52	49	33	8
38	10	63	70	29	66	4	57	13
5	11	58	18	55	45	26	43	31
14	27	34	6	21	39	59	19	28
20	44	74	67	71	64	35	54	81

On this chart point to each number in order from 1 to 81. Finishing within 12 minutes scores "excellent." From 12 to 16 minutes is "average." More than 16 minutes is a "poor" record

In order to attack the problem of what you can do, and how you can improve your abilities, take a complete mental inventory of yourself. This inventory should indicate your rating in each of these general tests:

Ability to read: Indicating ability in book work.

General intelligence: Giving a general idea of ability to achieve success.

General mechanical ability: Showing skill in manipulating things as against ideas.

General clerical ability: Showing natural aptitude for general clerical work.

General selling ability: Showing capacity for success in dealing with *people*. This is vital to a salesman, minister, or social worker. Consideration must be given also to the fact that diplomacy, rapid thinking, ability to "give-and-take" gracefully, quick decision and the ability to accept criticism impersonally are indispensable concomitants.

The tests I have mentioned furnish only the barest outline of the principles of the new science of vocational selection. They are sufficient, however, to reveal how the principles may be amplified and adjusted to fit almost any trade or profession.

I do not want to be understood as wholly condemning the rolling stone. Changing jobs may sometimes be beneficial, provided you know you are working upward, provided your brain and not your heart directs the change.

Square Pegs in Round Holes

One of the most prominent clergymen in the United States—a bishop—spent years as a newspaper reporter before he studied for the ministry. He had been fairly successful in the newspaper business, but he realized at last that he had advanced as far as possible and that his future outlook was bleak. Possessing the gift of language and deep religious convictions, he decided to enter the church. His success as a pulpit orator and executive has been remarkable.

There are many such cases of men attaining success after changing vocations. One I remember distinctly. For five years after leaving school the son of a business man of my acquaintance drifted into job after job, none of which he kept for more than a few weeks. Far from upbraiding the boy for his frequent changes of employment, the father encouraged him, though his business associates insisted that he was ruining his son's future prospects by this encouragement. Last year the young man entered the employ of a producer of moving pictures, and there at last found a business that really interested him. He is now secretary to the president and in line for an executive position of greater responsibility.

A recent study of the biographies of men in "Who's Who in America," shows that one out of every five changed the field of his occupation at least once in early life before finding the line of endeavor at which he succeeded.

No matter what your job, it is not the right one if it offers you no chance for promotion, for gaining wider knowledge, for accumulating responsibilities, nor if it saps your physical, intellectual, or moral strength.

These things you can determine for yourself. If you find you are not in the right job, do not be afraid to change. There is ample material in your nearest library to assist you in determining what that change should be.

A scene before an employment agency in New York City. In thousands of cases the men who alternate between unemployment and brief jobs possess special abilities that are never used

How Does Your Mind Count Things?

Tools of the Insects

Nature's Inventions Antedate and Excel those of Man

By Ernest Bade, Ph.D.

A Brush—used by ants to clean their feelers

Pliers—used by earwigs to adjust wings

MOST of the articles in that great chest of tools that man's inventive genius has contrived through the laborious, inventive ages were invented by the insect world before he fashioned the first. Moreover, his tools are usually inferior in precision and versatility.

For the toolchest of the insects is equipped with the most precise master tools, perfect in material, exquisite in workmanship, unexcelled in utility. Nature attached them to the insects' bodies—to the legs, to the head, to the abdomen, wherever they are needed. They are made of chitin, a material that, unlike the metal tools of man, resists the action of water and the milder acids, breaking down only under concentrated sulphuric, hydrochloric and nitric acids.

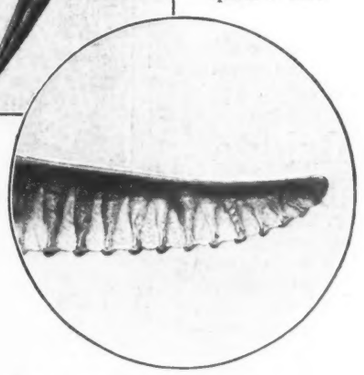
Saws, pliers, brushes, augers, hooks, hammers, knives, lancets—all these and yet other tools are in the insect's remarkable chest.

Probably no better example of the master tools of the insect world is furnished than by the saw of the sawfly. Two saws, placed close together, are carried by this insect. The upper part of each saw is braced and the teeth are on the lower side. Under the microscope, each large tooth is seen to be divided into a number of smaller ones. The upper, thickened part of the saw has a hollow groove, and when one saw is protruding, the other is drawn in. With this tool the female fly cuts a depression in a twig for her eggs.

The Rhyssa fly has a particularly formidable "keyhole saw," so strong it can cut hickory. This saw is as elastic as the most finely tempered steel blade and about as thick as a horsehair. The rhyssa is the enemy of wood-boring larvae found in the trunks of trees. By its organs of sense the rhyssa locates exactly the hiding place of the larvae, and draws forth its saw. For hours the cutting continues, until a larva is reached. The insect deposits its egg then within its victim. Sometimes the saw is driven four inches into tough wood. Withdrawal of the tool is sometimes impossible, becomes wedged in, the insect dying of starvation.

Contrasted to these sawing creatures are the wood-boring insects. The tremex has perfected the art of using a natural auger. The tool, which is as long as the carrier's body, is rigid, but so elastic that it will return to its original shape after bending. The tip has a sharp point and sharp, inward-curving teeth, and the shaft has a series of depressions. The depressions on the shafts are sharply edged along their entire length, smoothing the hole as they enter. In boring a hole for its egg, the insect lifts its body as high as possible, inserts the tip of the borer, bending its legs as the tool cuts in, until the insect at last is lying flat on the wood.

Circles above chest. Left: Borer of the pigeon-tailed wasp. Right: Comb on the spider's foot



Rectangle above: The stinging organ of most bees has recurved hooks which prevent its withdrawal by the insect. Circle above: The remarkably efficient saw of the sawfly. Circle at the right: Strong pliers, used by the wheat gall-fly

Man's ingenuity has made his hands defter craftsmen by contriving for them a crammed chest of ingenious tools. On that chest his civilization largely depends. Yet eons ago Nature armed the myriad hosts of his tiny foes, the insects, with most of these tools that his bitter need and his evolving brain had to fashion unaided. Many of these insect tools embody secrets that make them superior to any man made device

Grasping hooks—on feet of the parasitic sheep tick

Stilettos, lancets, and augers are the commonest tools of the insect world. Blood-sucking insects all carry stilettos with which they cut through the tissues of the victims until the blood vessels are bared.

Even the hammer is to be found in nature. The Brazilian beetle (*Passalidae*) carries upon one of the segments of the abdomen tiny chitin hammers that work upon string-like projections of the same material to produce a continued chirping sound. This beetle lives in runways of wood, and, unlike most other insects, cares for its young, using its hammer and the resultant chirp to call the larvae in the dark tunnels so that they can be fed.

The earwig is provided with a simple pair of pliers, which it uses for drawing its wings together after flight. When this animal alights, its wings fall unsymmetrically. It draws the wings closer to its short wing-covers, which permits the pliers to grasp the wings and pull them under the covers.

Structures that may be compared only with brushes are to be found on the front feet of beetles and ants. They are hemispherical hollows provided with bristles. A thornlike projection from the lower extremity of the body, likewise covered with bristles, permits the openings to be closed. The brush enables the insect to clean its feelers, which are drawn through the notch for this purpose.

The feet of the spiders are provided with "combs," not, however, for cleanliness, but to enable the insect to climb about its web. These tools also find a use in helping to weave the net.

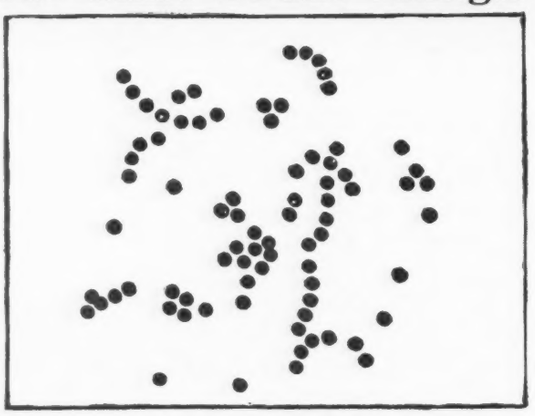
The insect toolchest is truly complete, one of its wonders being the closeness of the resemblance of the articles it contains to the tools that man has been so long fashioning.

How Does Your Mind Count Things?

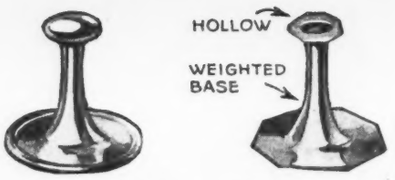
DO YOU think in fours when you count irregularly placed objects? If you can do that easily, you have a more mathematical mind than most. Most persons conceive of a group of four only with difficulty.

Many savage peoples use the same word for five and for numbers greater than five. Without reflecting, we do not realize that we, too, think in tiny groups of units. Most persons visualize seven as a group of three and two groups of two. A much smaller number of persons visualize it as groups of four and three. Numbers like 9000 are by most persons conceived as three groups of three units each.

Watch your mind as it counts the dots above, at the right. Note what groupings of units it tends to make. Unless the mind is wary, the confused arrangement will trap its tendency to group anything that is to be counted.



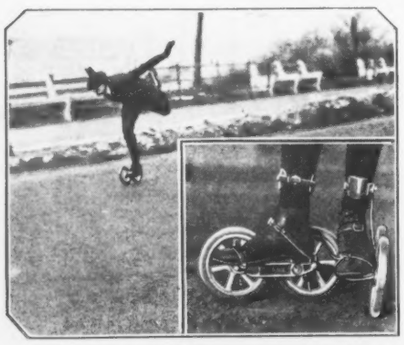
Are there 79 spots here?



The Roving Collar Button Is Hobbled

PURSUING the elusive collar button under the dresser has been an unpopular indoor sport ever since the invention of the boiled shirt. An ingenious Washington man at last offers escape in the form of a collar button that cannot roll. He accomplishes this by supplying his button with a weighted octagonal base.

The base of the collar button, being non-circular, cannot roll and the weight keeps it right end up, like the salt and pepper shakers on your table.



The new wheeled skate, and its inventor, suggesting new stunts

This Freak Wheeled Skate Creates New Sport

A NEW sport is here, "pedcycling," said to combine speed, skill, and thrills in a fascinating blend. Enthusiasts for the new sport claim it will make roller-skating seem drowsy.

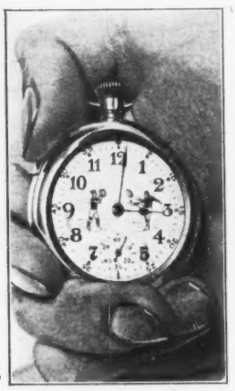
To each foot is attached, by straps and clamps, a "skate" consisting of two eight-inch rubber-tired wheels in line with each other. The foot rests upon a comfortable spring platform.

Speeds nearly as great as those possible with ice skates are said to be attainable.

Combined Watch and Timer without Second-Splitting

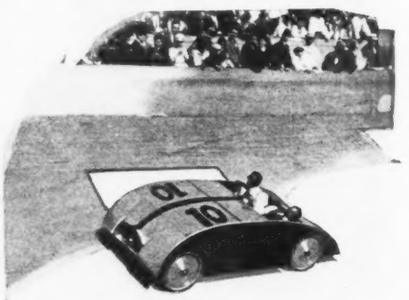
A GOOD stop-watch is a luxury. Keeping it in condition is expensive. Moreover, it can be used only for timing.

Many amateur games are timed by stop-watches when a less precise watch would be as practical. On the other hand, in tightly contested games an ordinary watch is inadequate.



The combination watch and sports timer here illustrated (which acts as a stop-watch except that it does not split seconds) should meet the timing needs of any amateur games. Besides, it serves as an ordinary watch. It has the usual black dial and also an outer circle of red figures. These latter are used when the watch is timing.

A lever protruding through the side of the watch and controlled by the operator's thumb starts and stops the watch.



Oddest Automobile Seen at Berlin Races

IN THE midst of all the striking sizes, shapes, and colors exhibited by the participants in the recent automobile races at the Berlin stadium, the car above was easily the oddest.

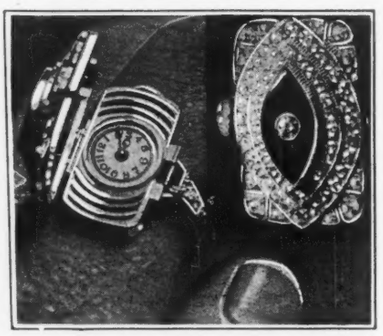
This car is one of the numerous automotive freaks recently turned out by the Koko Works, of Germany. It develops only five horsepower, yet attains considerable speed.

Curved Arch Built in New Bridge

Showing the curved arch in the Great Western Gateway. Right: Cement forms in place

WHEN the great Western Gateway, the fine bridge now being completed at Schenectady, N. Y., over the Mohawk River, has crossed the first half from the Schenectady side, it makes a decided turn to the right to meet the approach from the other end. This bend necessitated the construction of what is said to be the first curved bridge arch.

This huge bridge will span 4436 feet and will have cost, when completed in 1924, approximately $3,000,000.



A Tiny Watch Is Concealed within This Ring

SO TINY that it is concealed within a ring and so costly that an expensive automobile could profitably be exchanged for it, is the watch illustrated above. The picture shows its exact size, a half inch across the face and less than one eighth of an inch thick.

A tiny, secret knob releases the ring face, which is incrusted with platinum and diamonds.

The accuracy of the watch has not been sacrificed to its diminutive proportions in any degree.

France to England through

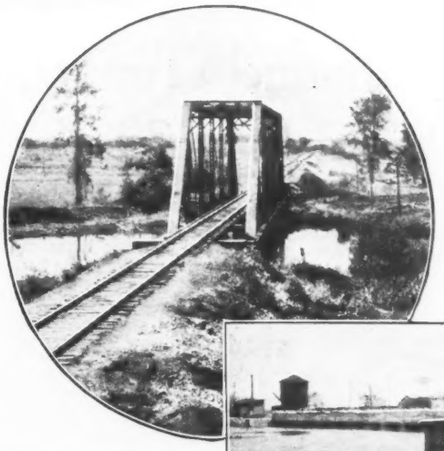
Bridge-Dam Draws Power from Tiny River

ACROSS the Huron River at Flat Rock, Mich., Henry Ford has recently completed a remarkable dam.

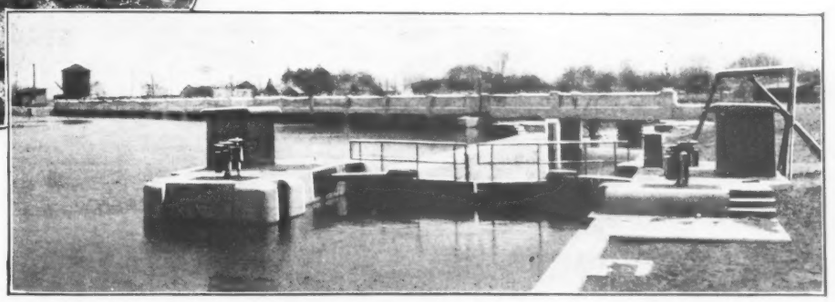
Usually where a dam is constructed, a bridge is built just below. To Mr. Ford this seemed a wasteful duplication of construction, so the Flat Rock dam is also a bridge. The Ford railroad crosses it and vehicles also are accommodated. Moreover, the bridge-dam widens the Huron River, making it possible to navigate barges on a stream upon which no craft larger than a rowboat ever before had been seen.

This distinctive piece of construction is the latest step in the prosecution of Mr. Ford's policy of harnessing small streams to generate power for community industries, supplying employment in agricultural sections during the winter.

The 700 horsepower generated at Flat Rock will operate a factory where bulbs for automobile lights will be made. The power plant will function also as a "booster" station in the power system. This railroad is now being electrified, the main power station being at River Rouge on the outskirts of Detroit. This project is typical of Mr. Ford's power plans. The Rouge River, which passes through his estate at Dearborn, for another example, has been harnessed four times in five miles.



At the left: The little stream and the railroad bridge on the dam site as they appeared a year ago. Note the sluggish nature of the stream



How Henry Ford's bridge-dam project transformed the spot shown in circle

Larger Cotton Yield Increase Promised by Freak Plant

BY GRAFTING cotton plants to the roots of mulberry trees, P. Dan George, a farmer of La Marque, Texas, has succeeded in producing a cotton plant eight feet tall containing more than 900 bolls. Three mother plants have produced 59 pounds of seed cotton, which, if carried out on a field scale, would result in the extraordinary production of four bales an acre. This Mr. George is attempting to do, and his experiments are being watched with intense interest by cotton growers of the vicinity.

George enjoys considerable reputation as a plant specialist, having developed giant peppers, seedless watermelons and cucumbers, cantaloupes three feet long and other plant curiosities.

Reclaiming the Sahara

VAST areas of the Sahara Desert can be made over into fertile pasture land, a food treasury for Europe's teeming population and limited agricultural areas, according to Gaston Imbeaux, chief engineer of the public works department of the French government.

He asserts that great stores of water underlie the desert and that artesian wells could tap them, as similar water supplies have already been tapped in arid regions of Australia.

Skilful Dynamiting Raises Old Dam

NOT long ago a ticklish situation faced the owners of a large New Hampshire factory. They had recently completed a costly concrete dam, and had laid production plans involving the use of a certain amount of power. This amount, their engineers had calculated, would be furnished them by a dam of just the size they had built. But it was not forthcoming.

A careful survey showed that an unused dam, built more than a half century before, was interfering with the flow of water over the new structure. The engineers had ignored it in their plans, partly because it was only a few yards from the piers of a bridge.

By a delicate piece of engineering, the old dam was dynamited bit by bit without injury to the bridge. The company's dam then began to deliver the necessary power.

Dynamiting the 50-year-old dam a few yards from the bridge

Generator Hauled across Mountains

PRIMITIVE transportation cooperated with electrical science in this invasion of Chile's mountains. Twenty-four straining horses, a rugged wagon, assisted by blocks and crowbars, gave their best to get this generator to its ultimate destination.

31-Mile Tube

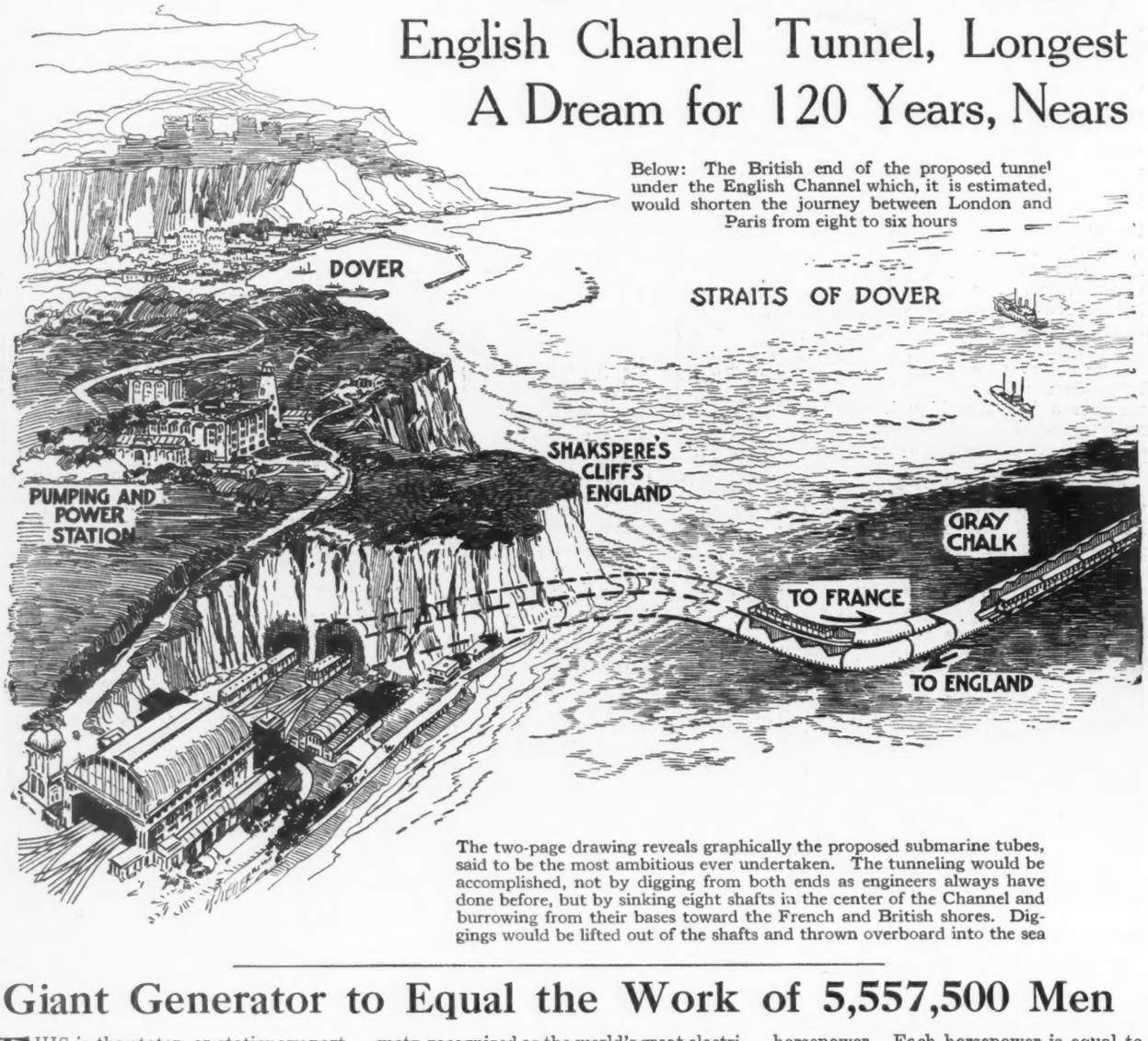
CALAIS,

France to England through

English Channel Tunnel, Longest

A Dream for 120 Years, Nears

Below: The British end of the proposed tunnel under the English Channel which, it is estimated, would shorten the journey between London and Paris from eight to six hours



The two-page drawing reveals graphically the proposed submarine tubes, said to be the most ambitious ever undertaken. The tunneling would be accomplished, not by digging from both ends as engineers always have done before, but by sinking eight shafts in the center of the Channel and burrowing from their bases toward the French and British shores. Diggings would be lifted out of the shafts and thrown overboard into the sea

Giant Generator to Equal the Work of 5,557,500 Men

THIS is the stator, or stationary part, of the largest electrical generator ever constructed, one of 87,000 horsepower, being built for the Niagara Falls Power Company by the General Electric Company. A twin generator is shortly to be built for the Commonwealth Edison Company of Chicago. Each of these monster machines, whose size is vividly revealed by the figure of the man standing within the statorwill weigh more than 700 tons and will be 26 feet high and 35 feet in diameter.

Very large numbers often do not impress the human mind as they should. They bewilder its power of conception. But the following statement, made recently by Dr. Charles P. Steinmetz, recognized as the world's great electrical wizard, conveys penetratingly the tremendous significance of 87,000 horsepower.

"One kilowatt equals 1.34 horsepower, so 60,000 kilowatts represents about 80,000 horsepower. Each horsepower is equal to the work of 22½ men, so 80,000 horsepower would be equal to the work of 1,800,000 men.

To make Niagara's plunging waters work like a vast army

"But a man cannot work 24 hours a day, while the turbine can and does. Therefore, this giant machine will do the work of three times 1,800,000 men. That is, it will furnish as much energy as 5,400,000 men working in three eight-hour shifts."

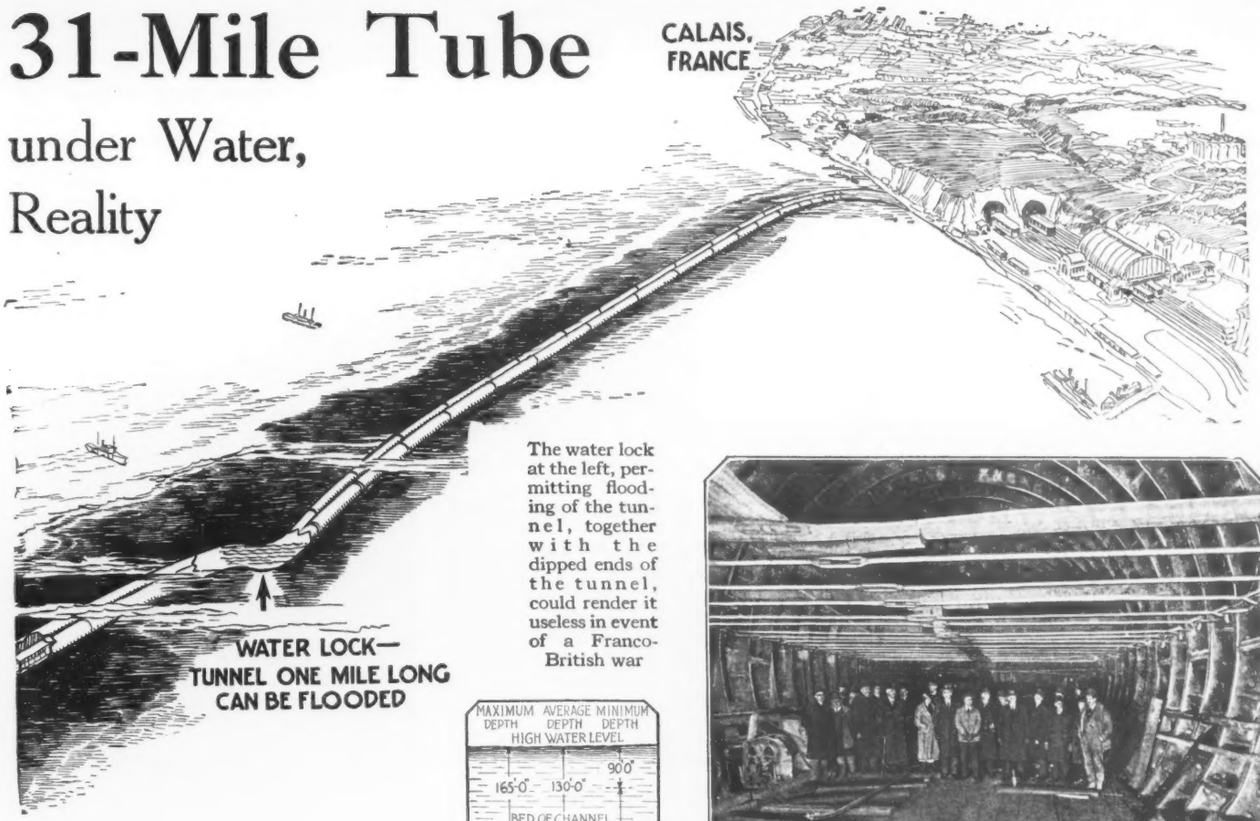
This means that the two generators, when completed, could, by joining their enormous energies, equal the muscle power of half the adult male population of the United States.

It should be noted also that Doctor Steinmetz, with the nonchalance inevitable in a scientist who summons and dismisses such incredible energies as only Olympian Zeus ever before commanded, blandly dropped 7000 horsepower from his calculations for the ease of using round numbers. That ignored energy makes each of the generators equal to the work of 5,557,500 men.

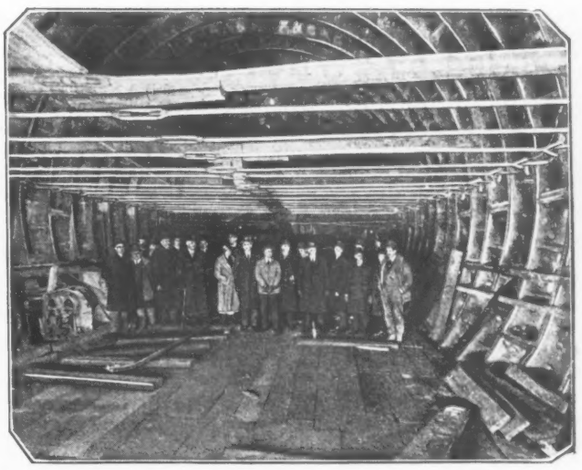
These generators do not actually create energy. They merely transform energy of another sort into electricity so that it may be transmitted long distances over wires. The first of these machines will transform the energy of Niagara's falling water; the second, the energy of expanding steam.

New York to Europe and

31-Mile Tube under Water, Reality

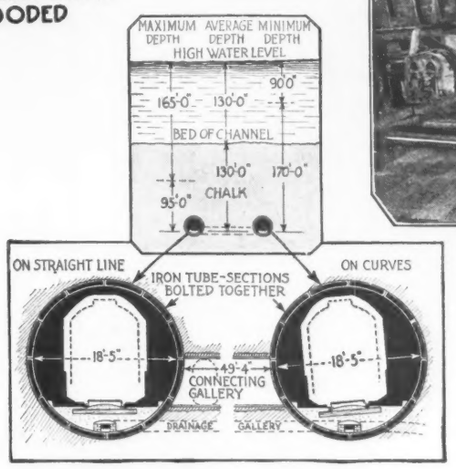


The water lock at the left, permitting flooding of the tunnel, together with the dipped ends of the tunnel, could render it useless in event of a Franco-British war



Above: New York and New Jersey officials inspecting the new Hudson River vehicular tunnel. The diameter of this great submarine tube, which is nearly 29 feet, makes it easily the world's largest tunnel.

The proposed Channel tubes, although much smaller in diameter than the Hudson River tunnel, would be many times longer

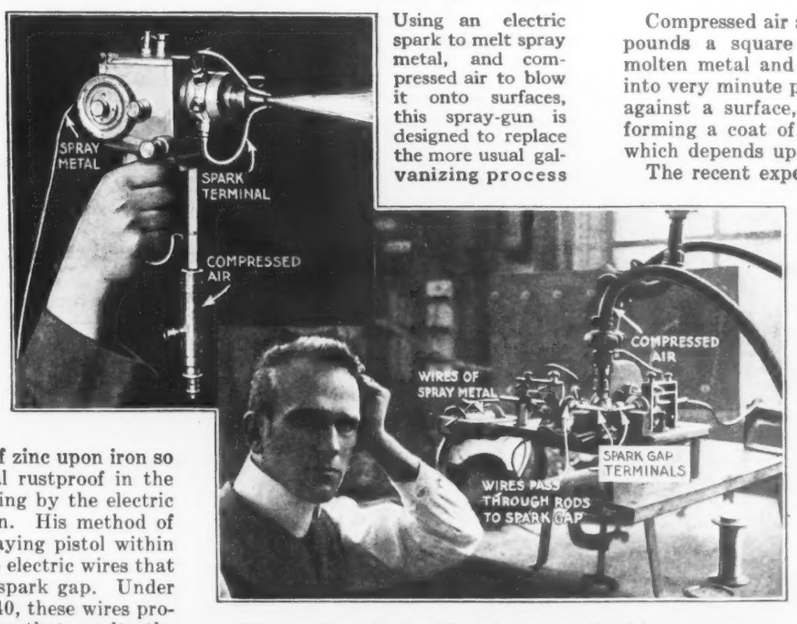


Right: Diagrams illustrating the construction of the two tubes that compose the tunnel, and their position under the Channel. Note also that where the water deepens, the depth of the tunnel lessens. The distance between the tunnel and sea level is thus always about 260 feet, a depth that is deemed amply safe

Compressed-Air Pistol Sprays Surfaces with Metal

A FURTHER development of the metal spraying pistol, invented several years ago by the Swiss engineer Schoop, is found in the recent reports from the laboratories of this inventor which indicate that he has succeeded in applying adherent and tight metal coatings to such materials as wood, paper, celluloid, and even to explosives.

As a result of his first experiments, Schoop sprayed a coat of zinc upon iron so as to make the material rustproof in the same way that galvanizing by the electric process seals up the iron. His method of spraying employs a spraying pistol within which are contained two electric wires that pass through rods to a spark gap. Under a voltage of from 30 to 40, these wires produce a small electric arc that smelts the end of a wire of the spraying material.



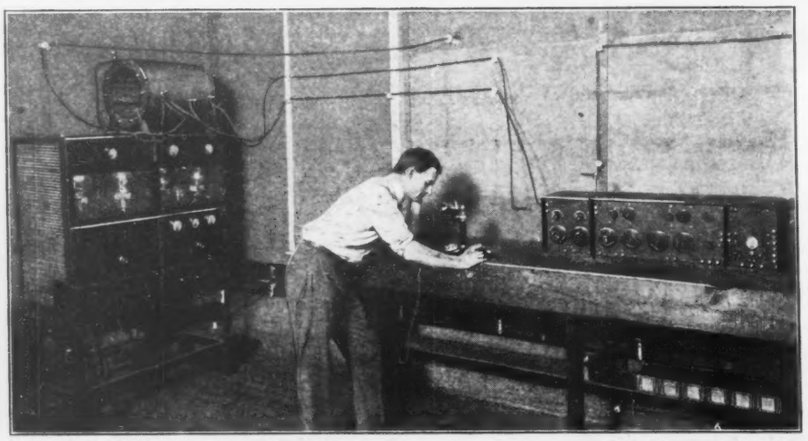
The spraying pistol, with casing removed to show arrangement of the electric spark and compressed-air mechanism

Using an electric spark to melt spray metal, and compressed air to blow it onto surfaces, this spray-gun is designed to replace the more usual galvanizing process

Compressed air at a pressure of about 55 pounds a square inch rushes past this molten metal and atomizes it, splitting it into very minute particles. When sprayed against a surface, these particles adhere, forming a coat of metal, the thickness of which depends upon the amount sprayed.

The recent experiments of Schoop have shown the feasibility of spraying other minerals than zinc, such as lead, tin, aluminum, brass, and copper. The fact that his recently improved pistol does not employ oxygen, but only acetylene and compressed air, is said to be an important development, since it materially reduces the cost of operation. The electricity consumed in melting the metals is said to be much less than that used where the material must receive an electrolytic bath.

Vacuum Tubes—How to Use Them



Receiving and transmitting station for "wired wireless" communication over power lines

Talking by "Wired Wireless" over Power Lines

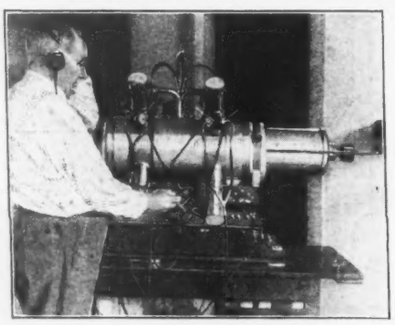
TELEPHONING over power transmission lines is now an accomplished fact. Westinghouse engineers recently installed at Battle Creek and at Jackson, Mich., successful stations for two-way communication, with complete transmitting and receiving apparatus at each end.

These installations represent a great advance in "wired wireless." Others have been merely adaptations of the familiar radio transmitters and receivers. They provided only one-way communication.

The dispatcher's set transmits at frequencies of 50,000 and receives at 60,000. The transmitter at the other station transmits at 60,000 and receives at 50,000.

New Apparatus Promises to Eliminate Static

STATIC, the electrical nuisance that sometimes mars the audibility of radio and the good nature of operators, now is being attacked by an invention under investigation by the Navy Department, the "clarophone," a device weighing 200 pounds and consisting of 10,240 pieces.



W. J. Scott and his static eliminator

In appearance the apparatus, invented by W. J. Scott, navy electrician, resembles an eight-cylinder airplane motor. Through eight tubes the received signals are carried to the interior, by telephone receivers connected through an amplifying circuit with the receiving apparatus. At the same time the messages are carried through a specially devised set of circuits that are said to free the signals of static interference. In short, messages are received electrically, not acoustically, and are clarified before they are heard.

Unfortunately, according to the navy investigators, "an enormous amount of amplification is necessary to give a signal equal to the intensity of one received on the usual receiving set with one tube." But these same men found it the most effective device tested.

The invention promises, when further developed, to make easier communication between airplanes or to noisy buildings.

Radio Concert Heard in Locked Bank Vault

Listening to a broadcasted radio concert inside a bank vault

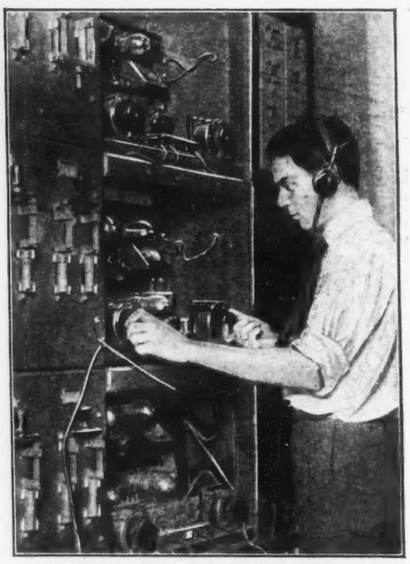
LOCKED inside the four-foot walls of their fireproof, burglar-proof vault, officials of a bank at Stratford, Conn., heard a radio concert broadcasted from the WJZ station in New York City, 60 miles away.

The entire receiving apparatus, including the aerial, which was of the loop type, was locked in the vault.

The unusual experiment serves to answer the question asked by many radio fans as to whether it was possible for radio waves to penetrate thick walls.

New York to Europe and Back in Three Minutes

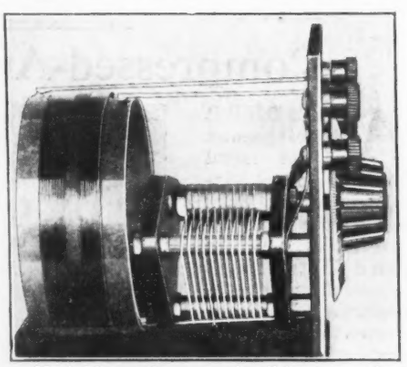
A MESSAGE traveling from New York City to Europe and back in three minutes is one of the recently achieved wonders of wireless. The photograph below was taken in the new RCA central station in New York City. From this station messages are sent at such speed directly to London, Paris, and Berlin, by means of the control station at Rocky Point, L. I. The picture shows the receiving apparatus that catches the signals automatically relayed from Rocky Point and transmits them to decoding operators.



Receiving a message at Radio Central

Interfering Stations Tuned Out by Selector

TO AID in tuning out interfering stations, an unusual selector, recently perfected, is equipped with an absorbing filter coil that serves to eliminate the broadcasting stations not wanted. This filter is connected in series with the antenna post of the receiving set, and hooked up with the variable condenser.



Variable condenser and coil hook-up of the newest model absorbing selector

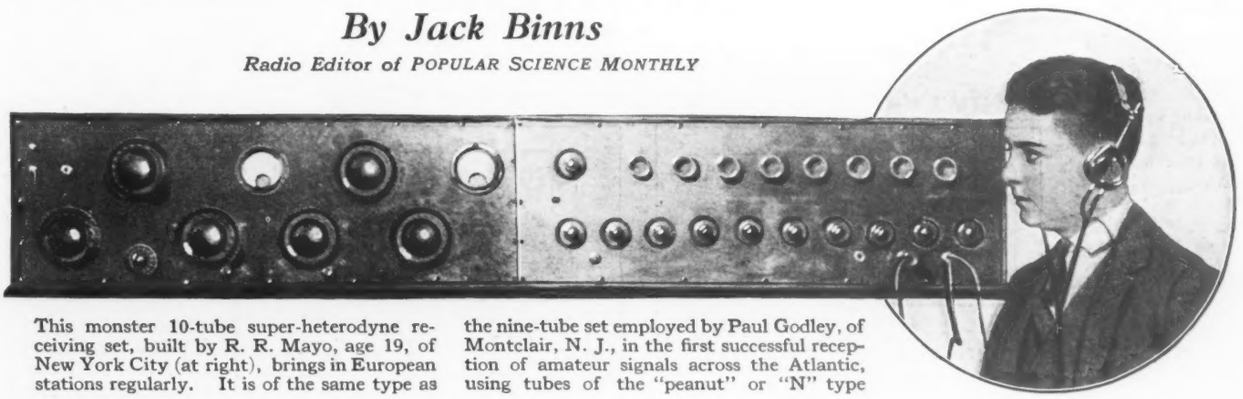
Undesired stations first are tuned in to greater strength by the selector. The dials on the set then are adjusted to bring in the desired station. By this method, it is claimed, interfering stations, once they are tuned out, cannot be brought in again by manipulation of the dials.

By using one or two selectors in series or in parallel, local stations are said to be eliminated for long-distance work.

Vacuum Tubes—How to Use Them

By Jack Binns

Radio Editor of POPULAR SCIENCE MONTHLY



This monster 10-tube super-heterodyne receiving set, built by R. R. Mayo, age 19, of New York City (at right), brings in European stations regularly. It is of the same type as the nine-tube set employed by Paul Godley, of Montclair, N. J., in the first successful reception of amateur signals across the Atlantic, using tubes of the "peanut" or "N" type

"WILL signals be increased if I add another B battery to my tube?" How often has the average radio fan asked himself this question? How often has he figured out that logically such a result should be obtained from the increased voltage from an extra battery, only to meet failure when he tried out his logic in practice.

The cause of his failure lies in the fact that he has not taken into consideration the limitations of the vacuum tube. That remarkable little instrument is somewhat like the camel, in that it can be loaded up to a certain point and no further. The last B battery may prove to be as fatal to the tube as was the proverbial straw to the camel's back.

All of this brings us to a consideration of the vacuum tube—its possibilities and limitations.

We can afford to ignore the transmitting tube here, since the average fan is interested almost exclusively in tubes designed for radio reception. There are just two functions for which the receiving tube can be employed—detection and amplification. The conditions governing its use as a detector are practically invariable, irrespective of the type of tube used. In amplification work, on the other hand, the conditions depend upon the frequencies of the currents to be amplified. For general practical purposes these frequencies may be divided into two groups, the first comprising those within the range of human hearing, and the second including all frequencies above hearing. We call the first group audio frequencies, and the second group radio frequencies.

Hard and Soft Receiving Tubes

It might be well to point out here that there are two main types of receiving tube, one known as "soft" and the other as "hard." The soft tube gets its name from the fact that it is not completely evacuated. It contains a certain quantity of gas that has a most important bearing upon its operation as a detector of radio currents.

From a technical point of view such a tube is the ideal detector, but in practical use its high receptive quality is really its chief disadvantage. In order to get it into its best operating condition, it is necessary to have every circuit about it arranged so that the smallest possible change can be made. This, of course, involves too many control elements for simple operation.

The soft type of tube is limited to detector action, and cannot be used as an amplifier with any degree of success. In fact, there are only two types of this tube available to radio fans in this country—the UV-200 and the C-300.

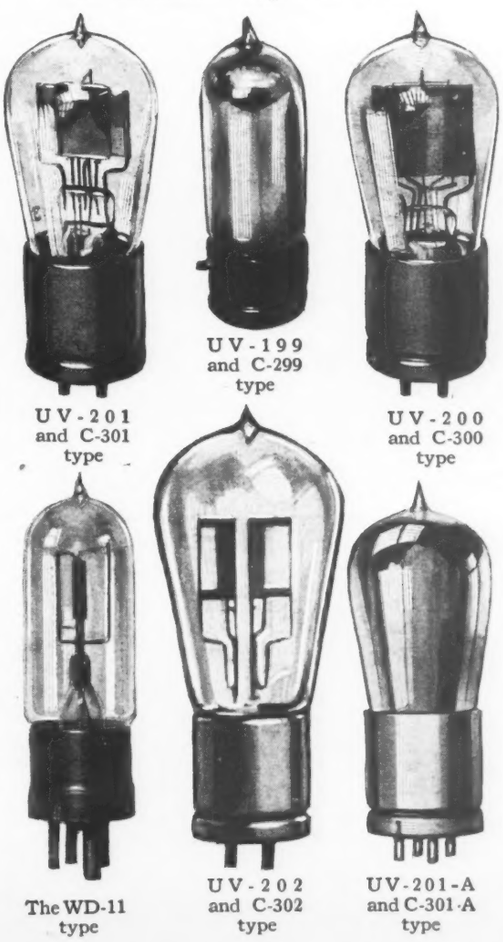
As a result of the rapid development of broadcasting with its great incentive to production, the manufacture of vacuum tubes has been revolutionized completely. Remarkably efficient tubes, recently produced, give unparalleled results with extremely low power consumption.

A few months ago the possessor of an N tube (the original peanut tube) was the most envied person in radio circles. Now low-power tubes are available to all. The development of these tubes has removed the most serious drawback to home radio by eliminating the necessity of a storage battery. It has made possible, too, the use of supersensitive receivers at a moderate cost.

While the different types of tubes now available are generally known, the individual qualities of each and the methods by which it may be used most effectively are not so well understood. Let us consider each tube individually.

First we have the UV-200 and its companion, the C-300. Each is a soft tube for detector purposes only. For average conditions it operates best with five volts on its filament, and a plate voltage varying between 18 and 22 volts. This requires a storage battery, as well as a variable resistance in series with one lead from the battery, in order to control the voltage and amount of current flowing through the filament. It is necessary also to use a B battery that can be varied. In fact, the best control of the plate current can be obtained through the use of a potentiometer placed across the A battery and then connected in such manner that the negative side of the B battery is joined with the movable arm of the potentiometer. This permits the smallest possible regulation of the current flowing in the plate circuit, and puts the tube in its most sensitive condition, although it introduces another control in the system. In the grid circuit of this tube it is advisable to employ a variable grid leak. The condenser associated with the leak should have an average value of .00025 microfarads.

Six Standard Types of Tubes



UV-201 and C-301 type

UV-199 and C-299 type

UV-200 and C-300 type

The WD-11 type

UV-202 and C-302 type

UV-201-A and C-301-A type

Two Types of Hard Tubes

Of all the types of hard tubes, let us consider first the new UV-201-A and C-301-A. This type of tube employs the thoriated tungsten filament, and consumes one quarter of an ampere at five volts. Thus, it is possible to operate the tube from four dry cells in series. This practice, however, is not recommended because of cost, and should not be tried except in single-tube receivers. The best results are obtained from this tube with a storage battery.

In appearance the new tube is somewhat like the old UV-201 and 301, but it has a filament half as long again. This permits construction of a grid and plate assembly of larger dimensions, increasing the output of the tube as an amplifier. It is ideal for use in conjunction with a loudspeaker on the audio side of a receiver. It can be used either as an amplifier or as a

detector. In the latter case it is not at all critical, and can be operated with a plate voltage of 45 volts, though in some cases the results will be better with 22 volts. Changes in plate voltage can be made in large steps. As an amplifier it will give clear, distortionless reproduction on the audio side, provided a negative bias is placed on its grid when the plate voltage is more than 45 volts. The tube will stand as high as 100 volts on the plate.

The diagrams on this page show how the grid return to the filament circuit should be connected when the tubes are used as detectors and amplifiers.

The UV-201-A and C-301-A have certain qualities that make them somewhat difficult tubes to use for radio frequency amplification, for they have a tendency to oscillate. The best way to damp out the oscillations is to place a potentiometer across the A battery, and control the grid circuit with the movable arm. When used as amplifiers of radio frequency currents, the tubes should have not more than 45 volts on its plate. Better results may be obtained with even less voltage.

Another storage battery tube is the Western Electric 216-A. This tube is designed solely for audio frequency work, and should not be used for radio frequency amplification, since its internal capacity is too high. It works on a six-volt storage battery, and it is not necessary to employ a controlling rheostat with its filament, which is not at all critical. It will stand as high as 150 volts on its plate circuit; but, as in the case of the UV-201-A, it should have a grid biasing battery.

Now we come to the various types of dry cell tubes, all of which make excellent radio frequency amplifiers because of low internal capacity. They are good detectors and fair audio frequency amplifiers. The original "peanut" tube—the Western Electric N type—is the smallest tube manufactured. It was employed by Paul Godley in the first successful reception of amateur signals across the Atlantic Ocean. In this particular case it was used in a nine-tube superheterodyne receiver.

The "peanut" tube operates on a filament voltage ranging between .5 and 1.1 volts. It consumes a quarter of an ampere, and consequently can be operated from a single dry cell. It will stand 40 volts on its plate circuit, a value that may be used either for amplification or detection purposes. Due to its small size, the tube will not work well as an audio frequency amplifier, although it can be used successfully for one stage.

In receivers using more than one tube of this type, there should be a dry cell for each tube. The dry cells can be joined together to form a common battery, but the connection should be a parallel one, not a series. Should the cells be joined in series—that is, positive to negative—the filaments of the tubes would be burned out. This tube, forerunner of all dry cell tubes, employs the oxid-coated filament.

Another tube very similar in physical characteristics is the WD-11, which also is produced with a standard base under the type number WD-12. Operating conditions of these tubes are almost identical with those of the N type so far as their use as amplifiers of radio frequency currents and detectors is concerned. The WD type, however, is much larger, and therefore is a much better amplifier of audio frequency currents. It can be used readily in conjunction with a loudspeaker. On the audio side of the receiver, it will stand as high as 100 volts on its plate circuit, provided a bias battery is used on the grid.

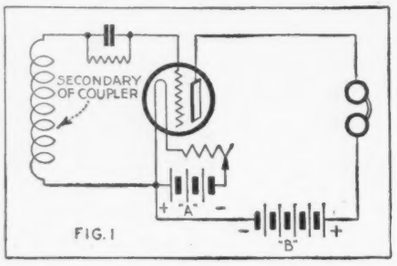
In amplification the WD-11, the UV-201-A and the C-301-A are approximately the same. Great care must be exercised always in conjunction with the filament voltage.

The latest type of dry cell tubes are the UV-199 and C-299 with thoriated tungsten filaments. These little tubes will operate from a pocket flashlight battery. They are perhaps the best radio frequency amplifiers because their internal capacity is comparatively low. Another point in their favor is the arrangement of the internal leads. The grid and plate leads are opposite each other instead of side by side. This, in conjunction with the fact that they use contact studs instead of prongs, tends to keep the capacity factor low.

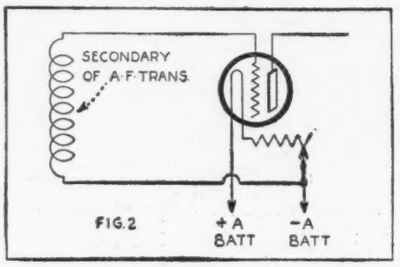
On the audio side, the amount of volume that can be obtained from these little tubes is amazing, considering the small amount of initial energy involved in operating their filaments. Great care, however, must be exercised in operating them. Dry cells should be used for the A battery, but in view of the fact that the tubes require 3.1 volts for best operation, two dry cells connected in series are not sufficient. Since it is necessary to use three dry cells joined in series, we are confronted with the question of reducing the voltage from 4.5 (when the cells are new) to 3.1. As a result, the ordinary filament rheostats are not suited for this purpose.

Where a single tube is used, it will be necessary to employ a 30-ohm rheostat. In case two tubes are used, connected in parallel in the circuit, a 20-ohm rheostat in series with the parallel connected filaments will do. For three-tube receivers a 10-ohm rheostat is sufficient. In each case, however, no tube should be removed from its socket while the A battery current is on.

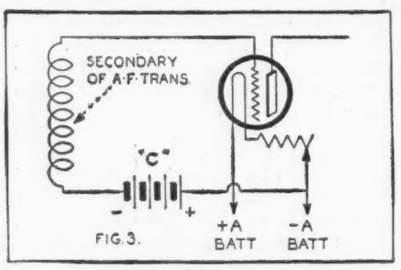
Grid Return Connections for Three Uses of Tube



When the tube is used as a detector, grid return to filament is connected with positive side of A battery, as indicated in Fig. 1



When the tube is used as an amplifier, grid return to filament is connected with negative side of A battery, as in Fig. 2



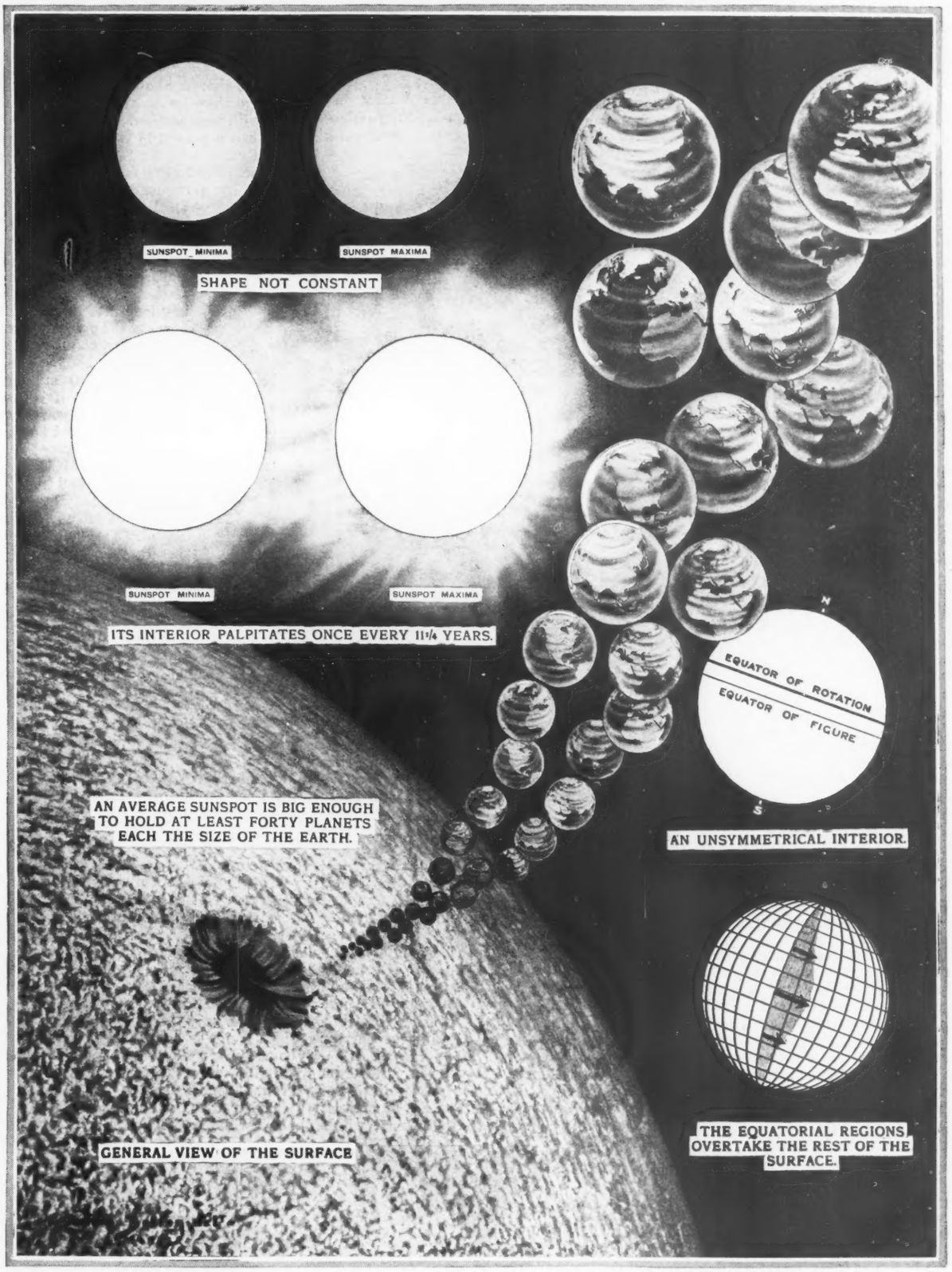
When tube is used as amplifier with C battery for grid bias, the grid return is connected with negative of C battery, and the positive terminal of C battery is connected with negative of A battery as illustrated in Fig. 3

Radio music not only increases the honey output of bees, but protects the keeper from being stung, according to John Bilon, a Long Island apiarist, shown above with his bee-taming radio set

IN NEXT month's issue Jack Binns will describe the various types of tuning elements and their uses in radio circuits. He will explain their relative merits with respect to selectivity, ease of operation, and general efficiency. These unusually instructive articles every month by America's most popular writer on radio subjects are designed to help the average fan understand seemingly complicated circuits and to learn their principles of operation. If you are designing your own set, or if you wish to get better results in radio reception, Jack Binns' monthly articles offer sound advice from an expert of long experience.

DANGER—High Voltage!

Our Fickle Sun and How It Changes the Earth


SUNSPOT MINIMA
SUNSPOT MAXIMA
SHAPE NOT CONSTANT
SUNSPOT MINIMA
SUNSPOT MAXIMA
ITS INTERIOR PALPITATES ONCE EVERY 11¼ YEARS.
N
EQUATOR OF ROTATION
EQUATOR OF FIGURE
S
AN UNSYMMETRICAL INTERIOR.
AN AVERAGE SUNSPOT IS BIG ENOUGH TO HOLD AT LEAST FORTY PLANETS EACH THE SIZE OF THE EARTH.
GENERAL VIEW OF THE SURFACE
THE EQUATORIAL REGIONS OVERTAKE THE REST OF THE SURFACE.

Drawn for POPULAR SCIENCE MONTHLY by Scriven Bolton, F.R.A.S. Copyright, Modern Publishing Co., Inc.

By Scriven Bolton, F.R.A.S.
Famous British Astronomer-Artist

THE more we learn about the sun, the more obvious it becomes that our luminary is not the steady light and heat giver it once was believed to be.

A number of the inconstant characteristics of the sun are illustrated above. For example, it has a palpitating interior that causes pulsation of light and heat sufficient to work marked physical alterations on the earth.

The sunspots—gigantic holes in the incandescent shell of the sun—are found to be cooler areas of the surface. It is significant that when these spots reach their maximum size and number, every 11¼ years, the temperature of the earth's surface area is lowered by about a degree. These cooler periods are accompanied by greater moisture in our atmosphere, and consequently a more abundant growth of vegetation. Sunspots are intense magnetic fields. The electrical discharges often collide with the earth, creating an electrical storm.

Scientific measurements prove that the sun's northern and southern hemispheres are not alike. The activities of the two hemispheres differ. Spots near the equator perform a rotation in less time than those in higher latitudes, actually overtaking the rest of the surface. The observed equator of rotation lies to the north of the equator of figure.

DANGER—High Voltage!

New Scientific Discoveries Show how Electricity Affects the Human Body

By George M. Ogle

Associate Member, American Institute of Electrical Engineers and Leading Authority on Effects of Electricity on the Human Body

MAN-MADE electricity kills twice as many persons in the United States each year as do all the lightning bolts that flash from the sky. Latest available reports show that electric light and power circuits cause nearly one seventieth of all accidental deaths. In every house lighting circuit, in high tension power wires, possible death or injury lurks unseen.

How these accidents may be avoided by a few simple precautions in the home and workshop is revealed by the newest scientific discoveries about the effect of electricity on the human body. Recent researches have proved that the amount of electricity flowing through a 100-watt light bulb commonly used in the home is enough to kill a person—if it passes through the brain or other vital organs of the body.

Yet I have known men to come into contact with tens of thousands of volts, under certain conditions, without suffering bodily injury.

In the past the popular belief has been that electric shocks are due entirely to voltage. Yet science now tells us that while the voltage of an electric circuit may be a contributing cause of death, it is only one of three important factors that determine the hazard of any circuit. They are these:

The pressure of the circuit in contact with the body. This is voltage.

The quantity of electricity flowing in the circuit, measured in amperes.

The resistance offered by the body to the flow of electricity under pressure, measured in ohms.

Use only one hand in switching electric lights on or off. Keep the other hand free from any metallic contact

Skin Is a Protection from Electricity

Our greatest protection in resisting the pressure of electric currents is our skin. It serves as a protective armor, highly resistive, to guard us from the deadly flow.

We might compare our skin, in its resistance to electric current, with a heavy piece of cardboard placed over the nozzle of a hose. If the pressure in the hose is comparatively low, the cardboard will hold back the flow of water for a long time before it breaks down. But if the pressure is increased, the water will burst through the cardboard quickly.

Similarly the resistance of our skin to the flow of electricity in a circuit varies with the amount of electrical pressure, or voltage, applied. When the skin is dry, it is a highly resistant insulator. But if it is wet, the current will seep through quickly. Then the blood and muscular tissues, which in the average healthy person contain nonresisting animal salts and liquids, offer excellent paths for the flow of heavy currents even under medium voltages. In fact, if the skin were severely cut in such a way as to offer direct electrical contact with the main blood arteries, the extremely low voltage of 50 would cause death.

Often, during electrical experiments, men have been heard to brag of their ability to withstand the tortures of an electrical shock from a low voltage circuit far better than their women associates. As a matter of fact the woman receives the greater punishment. This is because the resistance of the average woman's body is considerably less than that of man's. Her hands rarely are calloused; her skin is softer and her general physical condition is more delicate than man's. Any stipulated voltage sends a greater quantity of current through her body.

The resistance of any person varies from time to time, depending on conditions of blood and skin, as well as the amount of moisture or perspiration. A man whose body is thoroughly dry can stand a higher voltage than he could on a hot day when wet with perspiration.

When a person is subjected to an electrical current under 2000 volts with good contacts the feeling is as if the body were struck by a tremendously powerful blow at all points. In the fraction of a second he is knocked unconscious. The muscles contract and the limbs and features become contorted. If the current is applied for any length of time, the body burns at the points of contact.

At such a voltage the average human body would receive about 10 amperes of current, which, if converted into mechanical power, would be enough to light 800 lamps in the average home!

High powered circuits of 33,000 volts and more will cremate the body beyond recognition within a fraction of a second. Yet, strange to say, there have been cases where the victim, subjected to currents great enough to burn off his limbs, has regained consciousness and survived.

Reports of persons being killed by an ordinary 110-volt lighting circuit are numerous. Investigation of most of these cases, however, reveals that death was due to a defect in the wiring, permitting a high voltage current to enter into the supposed 110-volt household circuit, or that the victim died from some physical defect aggravated by the electrical shock.

Practise These Safety Rules

The house circuit usually is protected by numerous electrical devices to prevent high tension circuits from entering the home in the event of an electrical breakdown between high and low voltage circuits. Yet there have been cases where these devices have failed. The following safety rules can be practised easily in any home:

1. Use only one hand (preferably the right hand) in switching electric lights on or off. Keep the other hand free from any metallic contact that may form a return or ground conductor.

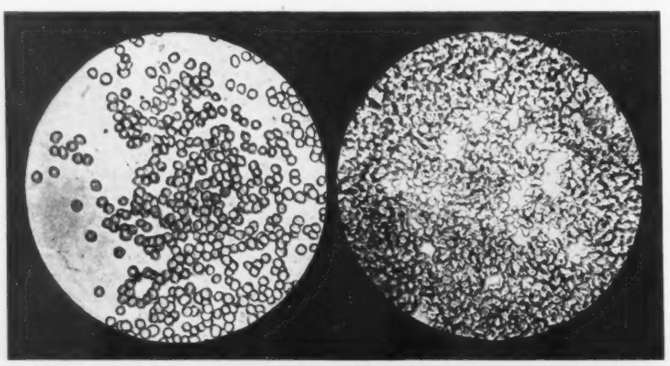
2. Never switch an electric light with one hand while the other hand is in the water or on the faucet of a kitchen sink or wash-stand.

3. Never operate an electric light while standing in a bathtub or shower bath.

4. Always be sure that the body and hands are dry when operating electrical devices.

5. Never tamper with electrical circuits with which you are not entirely familiar.

Observance of these rules may save your life.



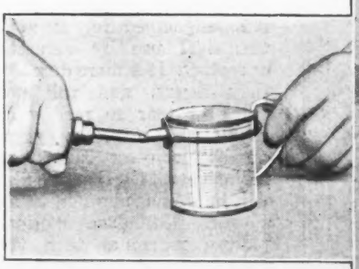
Typical blood corpuscles of a normal, healthy person

How blood corpuscles disintegrate after electrocution

IN AN early issue—A fascinating article describing the machine invented in France to extract electricity from the air for commercial use.

Home Movies with New Paper Film

More Household Ease, Safety, and Efficiency



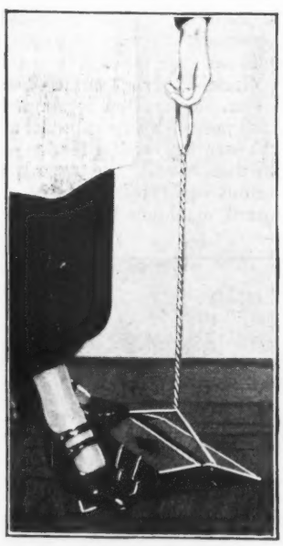
Sanitary pitcher made from a milkcan. Spout and handle are joined by an encircling spring. Piercer enters spout to make hole

This wooden holder for hot handles can be transferred easily from one handle to another. A simple spring attachment slides on and off handle

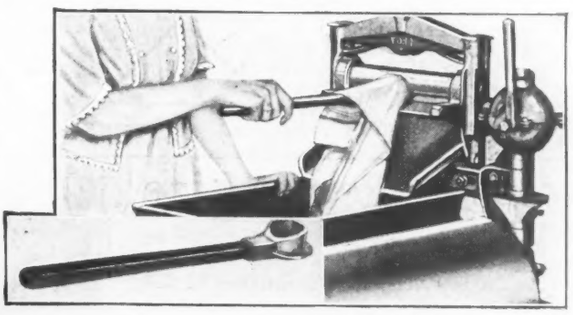
This gas range folds back against the wall. When thus collapsed, it extends only seven inches. It has four full-size burners and a 25½-inch top. A valve shuts off the gas when the range is folded back

This simple suction cup grips a fruit jar cover powerfully. Both hands are left free to twist the obstinate cover from the jar

Even small lumps are not spared by this relentless aluminum potato masher. It is claimed not to require scraping in cleaning



This pan obviates stooping and a foot lever will hold it against the floor

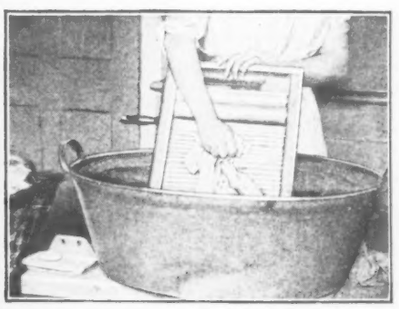


Squeezed fingers and scalded hands are said to be prevented by this clothes lifting stick

More than a score of branching rubber fingers on this mop attack germs and grease in odd corners of jugs and cooking utensils. A moment's flushing with water cleanses it for future use

Without leaving this sifter, flour may be sifted any number of times. When one sifting is completed, turn it upside down. Each end of the sifter has a lid

Baby's milk can be warmed in the nursery or anywhere about the house with this handy electric warmer

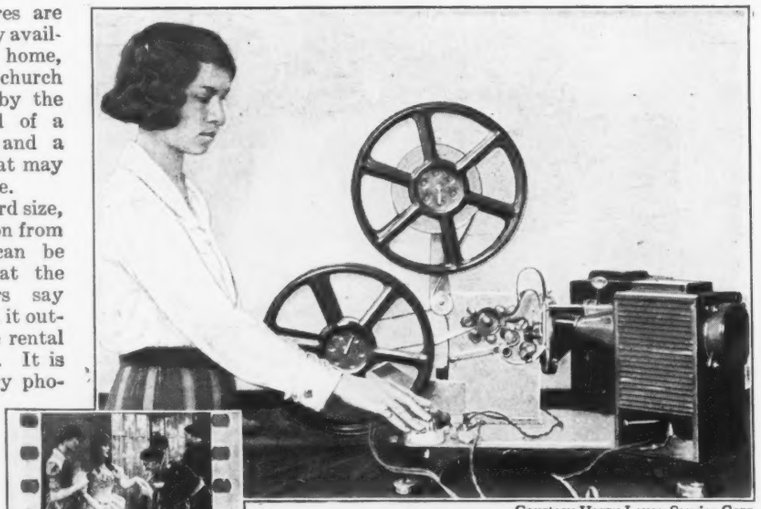


This combined wringer and washboard attaches to any ordinary set or portable tubs with a galvanized iron tray and flexible wire clip. The rollers furnish a 112-pound pressure

Home Movies with New Paper Film

MOTION pictures are made generally available for the home, the classroom, and the church and for similar uses by the invention in England of a fireproof paper film and a projecting machine that may be operated by any one.

The film is of standard size, permitting reproduction from any negative, and can be made so cheaply that the American distributors say they will be able to sell it outright for less than the rental price of celluloid film. It is sensitized like ordinary photographic printing paper, but is fireproof. Unlike celluloid film, which is projected on a screen by passing light through it from the rear, the paper film is projected by reflection, the light, furnished by incandescent lamps instead of carbon arcs, being directed against its surface from both sides of the projecting lens. The resultant picture is said to be very clear and to fill an eight-foot screen.

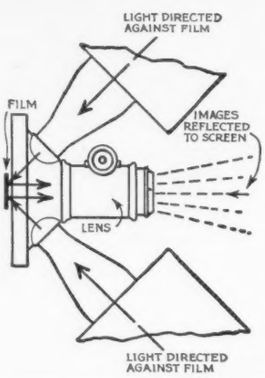


Courtesy Harry Levey Service Corp.

Left: A section of the new paper film, suggesting with what completeness of detail the invention reproduces a scene. Above: The projecting machine, showing reflectors and the course of the film

A unique feature of the apparatus is that it may be used as a giant microscope. Any object of a size capable of being placed within the opening through which the film passes in projection may be thrown on the screen in natural color and full detail, magnified 2500 areas.

The manufacturers claim many points of advantage for paper film over celluloid film, especially since it is designed entirely for non-theatrical use by amateur operators. It is more durable, they assert, and will not crack or tear so readily as celluloid. Again, the design of the projector is said to make it unlikely that the film will be damaged when being shown. Standard motion-picture machines turn the reels for projection by means of sprocket wheels that revolve through perforations in the sides of the film. The paper film, however, passes behind the lens on a roller, a sprocket being employed in the mechanism merely as a guide. Moreover, the picture surface of the paper film cannot be scratched, since it has no contact with any metal part. If the rear of the film is scratched, it is not evident on the screen, as is the case with celluloid film.



Right: A diagram showing how reflected light makes possible the use of opaque film. Ordinary motion picture film is penetrated by light from behind in projection

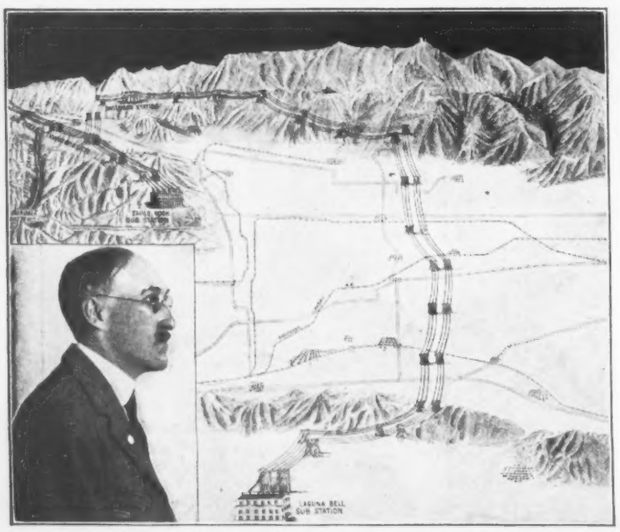
Since there is no open light and since the film is non-inflammable, the apparatus needs no fireproof booth, and requires no additional fire insurance premiums. The film may be sent through the mails in ordinary paper wrappings.

The projector is portable, weighing about 35 pounds. It may be packed into a small carrying case. The usual domestic electric current suffices for its operation. Operation is simple, any normal person being capable, it is said, of operating it after reading a few simple directions. The projector sells at about one third the price of the standard machines.

The Longest and Strongest Power Line

THE first considerable step toward the utilization of the tremendous water power resources of this country, which, as was told in the July issue of POPULAR SCIENCE MONTHLY, have been wasting their vast energies for years, has been taken by the Southern California Edison Company. This corporation has installed an electric transmission line capable of carrying 220,000 volts over a distance of 240 miles.

The route of the line, the longest and highest voltage transmission line in the world, is shown on the accompanying map.



The new California power line and its creator, H. A. Barre

More than two years' research work was necessary for the solution of the problems involved in thus enormously increasing the power of the lines, which formerly operated at 150,000 volts. More than a year was required to reconstruct them so that they could carry this record load. The lines connect the Big Creek power plant and the city of Los Angeles. Their conversion to the 220,000-volt capacity was accomplished under the direction of H. A. Barre, executive engineer of the Edison Company, who is shown in the insert.

Noise Photography Achieved, Claims British Inventor

"PHOTOGRAPHING noise" sounds like a slip of the tongue. But the British inventor of the supersensitive camera shown above claims that it will accomplish that remarkable feat. He asserts that noise causes rings of air to be formed and that these are capturable by photography sufficiently delicate.

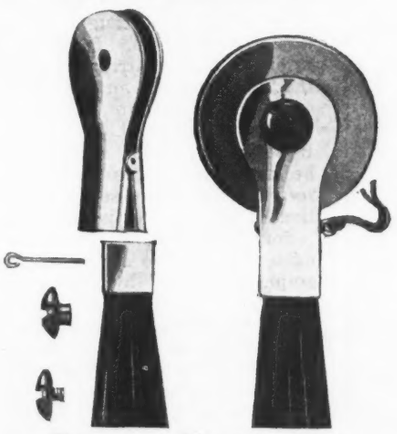
Not content with creating a scientific toy, he has set his sharp-eyed contrivance to analyzing the noises made by the exhausts of automobile engines, working on the theory that such sounds reveal unerringly the flaws in motor performance.

It is only within the realm of simple sounds that the camera is claimed to be effective. Its results with complex sound combinations are said to be valueless.

Sewing Machine Spotlight Saves the Eyes

A POCKET flashlamp, adjustably attached to the frame of the sewing machine and focused on the needle, not only adds to convenience in sewing, but saves the eyes of the operator in threading the needle or in guiding the work.

Handy Typewriter Eraser Can Be Renewed



The eraser holder and its parts

THIS new design of interchangeable typewriter eraser, offered by a Pittsburgh, Pa., manufacturer, permits longer use of the eraser and greater economy.

A set of erasers of the familiar circular type is provided, but, instead of being mounted permanently on a metal center, there is a separate holder to which a new eraser may be fitted when the old one wears out. By removal of the holder, the last fragments of an old eraser may be used. The holder is equipped with a brush.

A GORGEOUS "flower" show at the bottom of the sea, where strange plantlike animals rival in beauty the choicest blooms of our gardens and greenhouses, will be described in next month's POPULAR SCIENCE MONTHLY, with wonderful photographs that will amaze you.

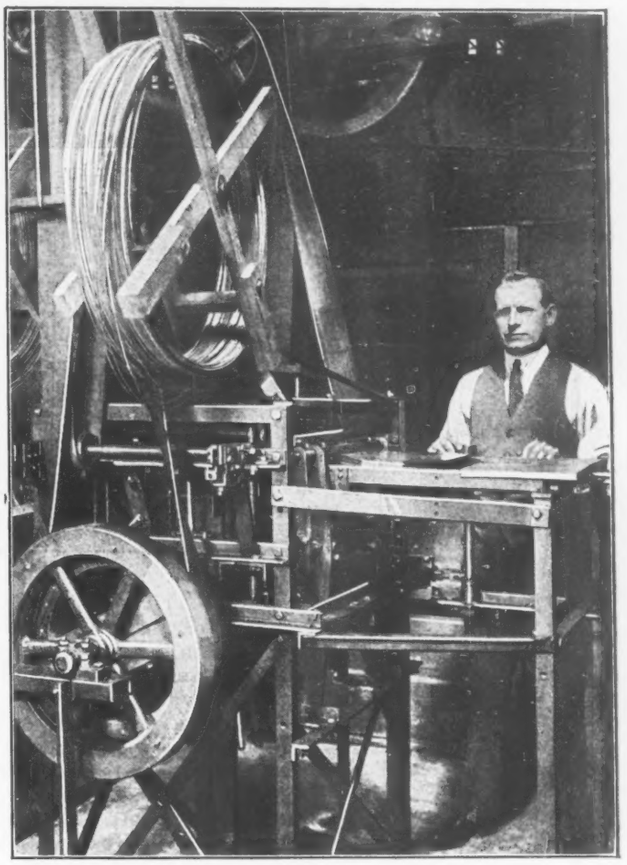
Also in the same issue, a remarkable article on how divers, armed with spears, plumb the ooze of the ocean bottom for treasures hidden in the bones of a sunken ship.

Turns Out 35 Kitchen Pans a Minute

SIXTY-NINE distinct claims for patents are made by W. J. Roepke, of Los Angeles, automobile and aviation engineer, for a high-speed pan-making machine that he recently perfected. This machine is said to turn out in one minute 35 finished one-piece pans of tin, aluminum, or sheet iron in any desired size or shape. It also is said to be the first new process offered the pan-making industry since 1867. Most manufacturers still employ the old punch and die method.

The Roepke machine, electrically driven, selects a sheet of metal from a pile, bends it, presses it, binds its edges with wire, and produces a finished pan with each revolution of its camshaft. Octagonal sheets of metal are used as shown in the illustration.

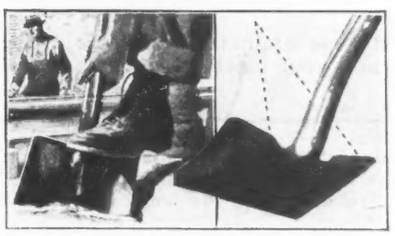
The steel arms of the machine take the topmost sheet, fold down ends and sides, fold the corner against the ends, bend the edges outward to receive the wire binding, take wire from the two rolls, bending each length around half the pan's circumference, roll the metal over the wire, bind it tightly and, finally, eject the finished product at the rear of the machine.



W. J. Roepke, of Los Angeles, and his pan-making machine

Different sized pans are made by changing the forms and folding mechanism. The machines themselves may be made larger or smaller, according to the needs of the users.

Mr. Roepke took two years to invent and perfect this wonderful machine.



Improved Shovel with Step Saves Worker's Feet

EVEN the common dirt shovel is capable of improvement. A new type, recently patented, is said to embody two distinct advances in shovel manufacture—a several-purpose step that saves the worker's shoeleather, and a phenomenally resistant metal.

The step adds stiffness and strength, making the blade safely usable as a crowbar in small jobs. It also prevents cracking along the line where the iron strap is welded to the blade, usually the fatal center of shovel collapse.

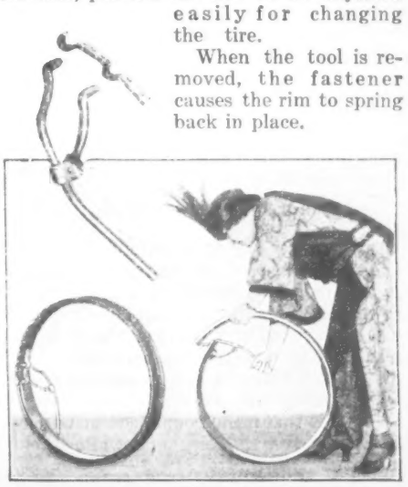
The step saves not only wear on the shoes, but also the strain on the arches of the foot, often caused by the long continued contact with the sharp upper edge of the blade. The special steel of which the shovel is constructed is said not to curl at the edges, and to wear unusually long.

Changing Tires Made Easy by Rim Fastener

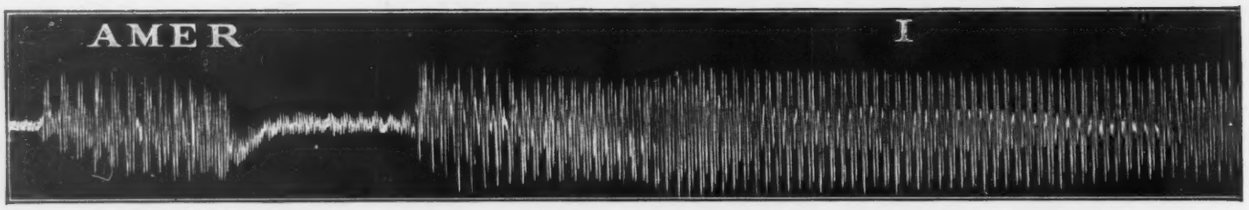
PUTTING on the tube and shoe of an auto tire is made an easy task by a simple attachment that also prevents the rim from springing. It consists of a metal fastener bolted across the joint of the rim, holding it rigid and in line.

A special tool, when inserted in the fastener, permits the rim to be adjusted easily for changing the tire.

When the tool is removed, the fastener causes the rim to spring back in place.



Adjusting rim with tool shown above



A record (reduced) of the word "America," made by the oscillograph. Although the utterance of the word required less than a second, the reproduction of its vibrations is more than three feet long. Note how the vibrations in the syllables merge.

The Great American Voice

Fitting 13,000,000 Telephones to 110,000,000 Talkers

By R. W. King
Editor of the "Bell System Technical Journal"

IN THE United States there are 13,329,379 telephones—64 per cent of the total number in the world, according to statistics recently compiled by the Bell Telephone System.

The engineers who maintain this vast number of instruments as an efficient working system have just made some surprising announcements as a result of their research work.

They say that all voices, male or female, harsh or soft, young or old, no matter how they may sound to our ears, actually are alike, in the sound vibrations they produce.

They tell why some people can be understood over the telephone, while others cannot.

They explain why we cannot recognize familiar voices over the phone.

They let us *see* the sound of our voices.

They tell us why the Central girl says "thr-r-ree," and they answer other similar questions that every telephone user wants to know.

Read these fascinating new facts about your phone and your voice!

THE telephone in your home is built scientifically to fit your voice.

This may surprise you at first thought since your telephone looks exactly like every other telephone. Indeed, it *is* like every other telephone. In no other industry, not even in the automobile industry, has the standardization of parts been carried farther than in the making of telephone apparatus. And yet the telephone is designed scientifically to fit *your* individual voice.

Fitting the telephone to your voice is a different proposition than fitting shoes to your feet or a hat to your head. When you purchase a pair of shoes or a hat, you get them because they conform in size and shape to your feet or head. Making a fit of this sort is a relatively simple matter, for it involves merely the selection of the one right hat for you, or of the one right pair of shoes. But fitting a telephone means designing a delicate instrument that will adapt itself not only to your individual voice, but at the same time to every other voice. In other words, it means fitting an entire telephone system to every human voice.

In spite of this fact, the fitting has been accomplished successfully through experiments carried on in the laboratories of the American Telephone and Telegraph Company and Western Electric Company, the results of which recently were announced. Now, while you may have to try on a half dozen pairs of shoes to find the right ones, you can take up any telephone and know that it will serve you as well as any other telephone in the entire system.

And what are the results of these investigations by the telephone engineer in his laboratory?

Telephone Questions and Answers

Among other things, an exhaustive study of the properties of human speech has put the telephone engineers in a position to answer questions that at some time or other must have vexed every person who ever has put a telephone receiver to his ear.

Why does the girl in the central office habitually say "thr-r-ree"?

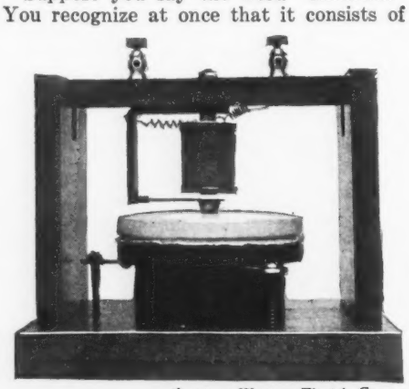
Why is it that some people can be understood easily over the telephone, while others can not?

Why do familiar voices—often those of intimate friends or members of our own families—sound different over the telephone than in face-to-face conversation?

The qualities in which all voices are similar can be understood best by observing how the telephone engineer studies the amazing intricacy of human speech.

Speech, as nearly every one knows, consists of sound waves or vibrations in the air. The vibrations receive their impulse from air released from the lungs through the vocal cords. Their character and form are regulated by the organs of articulation—the tongue, the roof of the mouth, the teeth, the lips.

Suppose you say the word "America." You recognize at once that it consists of four syllables, each syllable being different from each of the others. If you observe a little more closely as you pronounce the word, you notice that the syllables merge into one another, not by quick jumps, but by a sort of blending which consists of a rapid series of very small changes. Observing even more closely, you probably will note that the sounds of the syllables themselves change gradually from beginning to end.



Courtesy Western Electric Co.

Alexander Graham Bell's first telephone instrument of 1875, from which our modern telephone system has grown

The telephone engineer, however, does not trust to the more or less haphazard evidence of his ears. Through delicate scientific instruments he has learned that when we speak the word "America," an extremely complicated train of sound issues from our vocal cords, to be caught by the ears of our listeners. In his laboratory he has a contrivance called the "oscillograph," an instrument that literally permits him to see the sounds of the human voice. By this instrument, speech may be visualized and a permanent record made of the sound vibrations of which speech is composed.

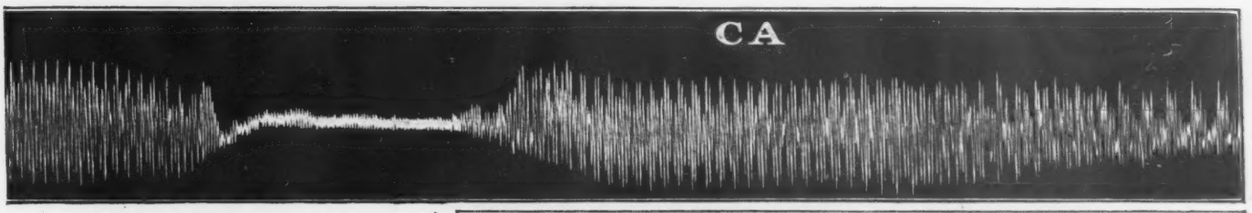
Sounds uttered into the transmitter at one side of the oscillograph are carried by connecting wires to a large spindle at the center, where they are recorded photographically on a film. The picture across the top of these pages is an oscillograph record of the sound waves that make up the word "America." But even this record, although it looks extremely complicated, is in reality considerably simplified by the omission of the more rapid waves of the voice. The omission is intentional, for the particular oscillograph used was incapable of recording vibrations above about 2000 a second. Had another type of oscillograph been employed, vibrations of the voice extending up to about 5000 a second would have been photographed. However, after glancing at the very complex record of a single word, we can appreciate the remarkable wizardry of the ear, which receives literally millions of these rapid vibrations and synthesizes them into intelligible speech.

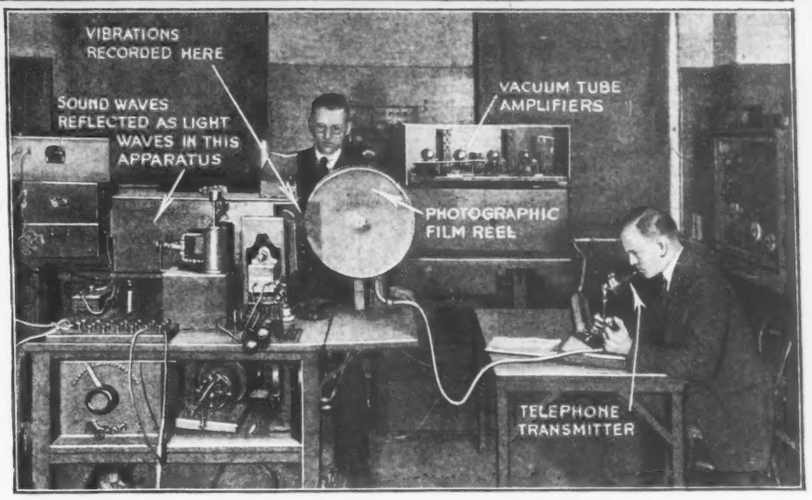
All Voices Are Similar

Records of the oscillograph have demonstrated conclusively the similarity of all voices. Records of the word "America," if made by a hundred different voices, would appear substantially the same, because the movements by which the organs of articulation produce the sounds making up the word are the same for all speakers, and would produce in the air sound waves of the same frequency of vibration.

"Lawn Mower" Cuts River Weeds

Left: The all-




VIBRATIONS RECORDED HERE
SOUND WAVES REFLECTED AS LIGHT WAVES IN THIS APPARATUS
VACUUM TUBE AMPLIFIERS
PHOTOGRAPHIC FILM REEL
TELEPHONE TRANSMITTER

Above is the oscillograph, the remarkable instrument that records pictures of the human voice for analysis of its vibrations, as shown in the record of the word "America" at the top of the page. Voice sound waves from the transmitter at the right pass to a vacuum tube amplifier, thence to the recording apparatus at the left. Here they produce oscillations in a vibrator placed before a mirror on which is levelled a pencil of light. A photographic film, revolving on the large spindle in the center, records the vibrations pictorially

The personal equation, of course, cannot be entirely disregarded. Different habits of articulation—the slurred speech of one man, or the distinct, careful enunciation of another, or a difference in the volume of sound produced by the various speakers, due to their different manner of speaking—would cause the records to differ to a greater or less degree in intensity, but the *frequency* of vibration would be the same in all.

As a result of thousands of observations upon speech sounds made by means of the oscillograph it has been found that the higher frequencies of the voice—of which we are not conscious as we listen to speech, and which make up not more than five or 10 per cent of the total energy of speech sounds—contribute enormously to the intelligibility of those sounds.

It has been found that sounds such as *th*, *f*, *v*, *s*, and *z*, are the most difficult to understand because they depend upon very high frequencies. Some frequencies of *th*, *f* and *v* exceed 5000 a second, which is about the maximum frequency of human voice waves. This fact explains, among other things, Central's fondness for rolling her *r*'s when she pronounces the word "three." In her training for telephone work she has been instructed that the *th* sound is difficult to hear over the wire and must be accented if it is to be understood.

Central's Rolled R's

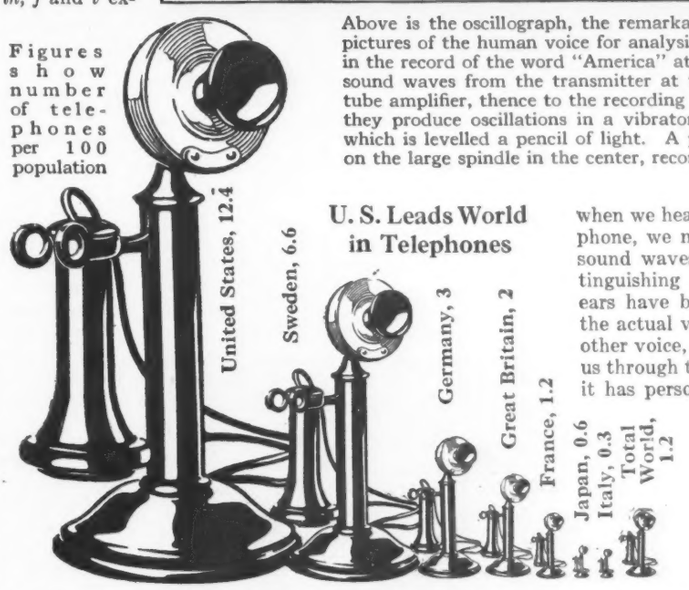
In the operator's effort to speak the difficult *th* sound intelligibly, she usually puts so much stress upon it that it becomes something like "thuh," and this causes her to make two syllables of the word "three." Her natural inclination after pronouncing the syllable "thuh" is to give the *r* a roll. Try it yourself and then you will see how it works.

The difficulty of carrying the sounds mentioned above over the telephone line also explains the difficulties experienced by a person who lisps or has some other impediment in his speech that prevents him from uttering those sounds distinctly when he attempts to make himself understood over the telephone.

In the list of sounds that are easy to understand is the word "four." The operator rarely requests the telephone user to repeat when he calls a number including a four, and yet this word contains a sound that is especially difficult of transmission—*f*. The reason for this is that the long *o* sound in the word is one that can be interpreted correctly almost every time it is spoken over a telephone.

Long *e* is another sound which is easily understood over the telephone. So is *l*. Names designating telephone exchanges first must be words made up of sounds that carry readily over the wires and that differ from one another, particularly in their consonant sounds; indication of their geographical locations is of secondary importance.

Two numbers that are quite easily confused when spoken over the telephone are "five" and "nine." Each word is characterized by the long *i* sound, which is very easily transmitted. The differentiation between the two words hinges on certain subtle differences in the consonant sounds that are difficult to transmit. It is for this reason that the exchange operator is taught to differentiate between them by pronouncing "nine" in two syllables, thus—"ni-yen."



Why Telephone Voices Are Different

The reason familiar voices are frequently unrecognizable over the telephone is that the modern commercial telephone apparatus does not transmit *all* the frequencies of the voice. Experiments with the apparatus already described have taught the telephone engineer that certain voice frequencies may be filtered out of a telephone line without loss of intelligibility. Since the telephone is a commercial proposition and manufacturing costs must be kept as low as efficiency will permit, the commercial telephone is designed to carry only those frequencies that have been found necessary to intelligibility. In consequence, when we hear a friend's voice over the telephone, we may hear it stripped of certain sound waves that usually give it the distinguishing characteristics to which our ears have been accustomed when hearing the actual voice. In other words, it is another voice, a changed voice, that comes to us through the telephone receiver, although it has personality and can be readily distinguished from other voices.

For experimental purposes in the laboratory, perfect telephones have been made. That is, they carry all waves of the voice and preserve all the refinements and individual characteristics of intonation and inflection. The commercial telephone, however, does not have to meet this very high requirement. If it transmits speech intelligibly, the loss of minor inflections is of little consequence.

To refine telephone apparatus to the point where it would transmit speech, not only intelligibly, but with perfect fidelity as to inflection, would make telephone service so expensive that nobody could afford it. There would be no more point to such refinement of telephone apparatus than there would be to the use of only chemically pure salt and sugar in the kitchen where the commercial grades are quite good enough and the chemically pure articles might cost thousands of times as much.

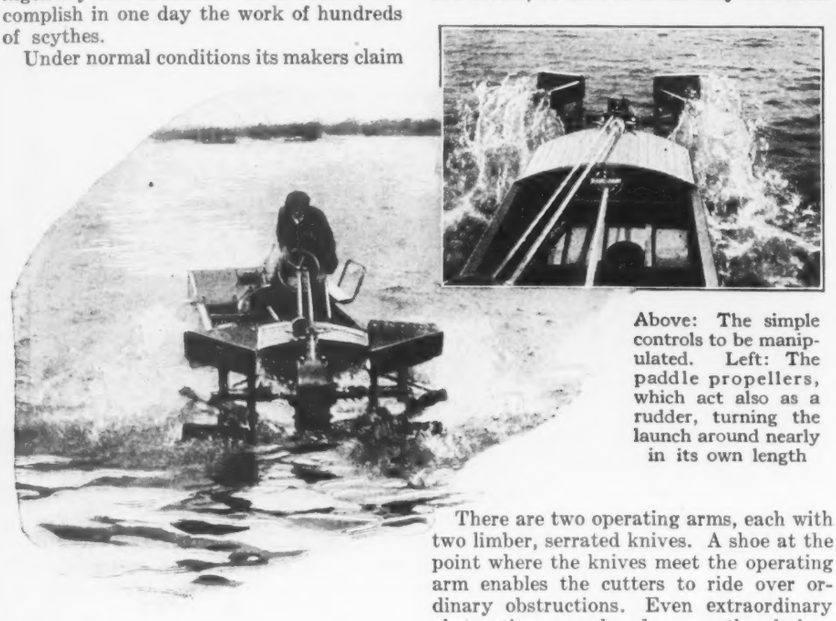
HOW to supply and circulate an abundance of fresh air in inclosed buildings where large crowds of people gather has been one of the pressing health problems of modern life. Read, in an early issue, how science is finding a solution by the invention of remarkable indoor "weather making" apparatus.

"Lawn Mower" Cuts River Weeds

A "LAWN MOWER" for weedy lakes, rivers, and ponds is a recent addition to the fleet of nautical oddities that man's ingenuity has launched. It is said to accomplish in one day the work of hundreds of scythes.

Under normal conditions its makers claim it will cut as much as five acres an hour.

The mower consists of a shallow draft, flat-bottom hull, somewhat resembling an ordinary motor launch. The propeller, which is also the rudder, is of the paddle type. A screw propeller would tend to wash away the underwater base of a bank and would clog with weeds. The operation of the boat and cutters is controlled by a very few levers, so that it needs only two men.



Above: The simple controls to be manipulated. Left: The paddle propellers, which act also as a rudder, turning the launch around nearly in its own length

There are two operating arms, each with two limber, serrated knives. A shoe at the point where the knives meet the operating arm enables the cutters to ride over ordinary obstructions. Even extraordinary obstructions rarely damage the knives seriously, because of their flexibility.

The angle at which the knives are placed permits free clearance of the weeds.

The makers of the cutting launch declare that they have found no water weed able to resist it.

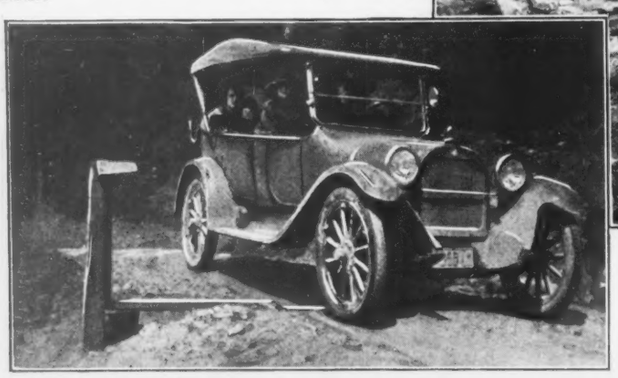
Passing Autos Are Counted by Box of Springs

THE apparatus illustrated below automatically registers the number of automobiles passing over a road. It was devised by a ranger of the United States Forest Service for use in the national forests.

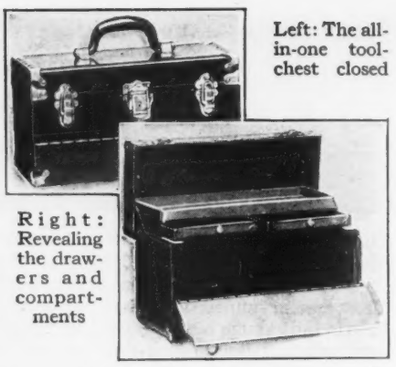
A steel box is sunk in the road with its lid flush with the surface. The lid is supported by six coilsprings, each capable of bearing a weight of 400 pounds.

The lid is a lever with its fulcrum 18 inches from a post in which is inserted a rod. This rod is pressed upward as the wheel of an automobile passes over the lid.

A registering device is operated when the lid springs back into place as the weight of the automobile is removed. Each pair of wheels registers, the number of vehicles passing being half the number shown on the register. The apparatus has registered an automobile traveling at 55 miles an hour.



Above: A ranger inspecting the U. S. Forest Service auto tallying device. Left: Tallying a passing machine



Left: The all-in-one tool-chest closed

Right: Revealing the drawers and compartments

Every Tool Has Its Place in This Chest

PRACTICALLY every tool a mechanic requires is said to find a place in this recently invented chest. Ingenious advantage of each cubic inch of space is taken to accomplish this end.

Small tools are carried in drawers and large ones in a specially contrived section. The case is said to be arranged to carry 100 pounds of tools. It opens and closes like a suitcase, and is carried like one. The material is vulcanized fiber, and self-raising traps and combination drop fronts are provided to help it withstand rigorous usage.

Tractor Drivers Are Protected from Fumes by Muffler

HEALTH and efficiency are protected, it is claimed, by this new tractor muffler. It is designed to keep from the lungs of the drivers the carbon monoxid fumes with which exhaust gas from gasoline engines is laden. The dangers of these fumes were described in the September issue of POPULAR SCIENCE MONTHLY.

The muffler is attached to the exhaust manifold directly, and is equipped with a deflector that throws the gases forward. By thus directing them, the device prevents them from striking the ground and raising dust.

It will be noticed that the long exhaust pipe is eliminated by this appliance. The makers claim, however, that this has no bad effects on muffler or power.

Planes Attack Mosquitoes

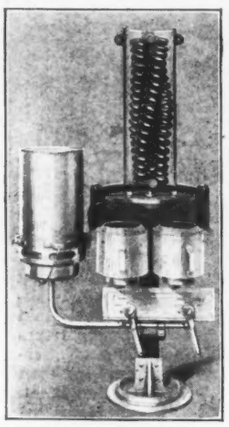
ATTACKING mosquitoes with airplanes seems, offhand, like stalking germs with a club. But in Alsace-Lorraine, where the breeding places of these insects are being spread with oil by low-flying planes, strikingly successful results are claimed.

That part of France, because of its hundreds of marshes, used to suffer from annual hordes of these notorious pests. It long has been known that oil prevented such breeding, but the problem of spreading it in the inaccessible inner parts of the marshes seemed insurmountable, until some one thought of airplanes.

Economical Water Heater Burns Kerosene

BANISHMENT of all condensation troubles and a coil arrangement that applies maximum heat to the coil surface are advantages claimed for this new kerosene-burning water heater. Attached to a boiler, it supplies running hot water to every part of a house.

Condensed water vapor is taken care of by the preheater head, a top-shaped attachment at the bottom of the coils. Its upper surface slopes toward openings that convey drippings from the coils over the edge and down to the tapering point of the head, whence they drop between the burners into a cup.



The heater with casing removed

The exaggerated twist shown in each of the four coils is designed to trap all the heat.

What to Read in Science

A Résumé of Recent Publications

ESTIMATING the Cost of Buildings, by Arthur W. Joslin, U. P. C. Book Company, New York. Revised edition of the writer's earlier work on this subject. A comprehensive handbook of building construction. Illustrated.

WHAT to Eat in Health and Disease, by Benjamin Harrow, Ph.D., Associate in Physiological Chemistry, College of Physicians and Surgeons, Columbia University. Dutton & Co. A non-technical but scientific guide for those who want to know what to eat and why. Illustrated.

A MANUAL of Artificial Respiration, by Capt. G. R. G. Fisher. The Stratford Co., Boston, Mass. A handbook of first aid treatment, describing means to be used in reviving victims of drowning, asphyxiation, shocks, sunstroke, poison, freezing, and blows. Illustrated.

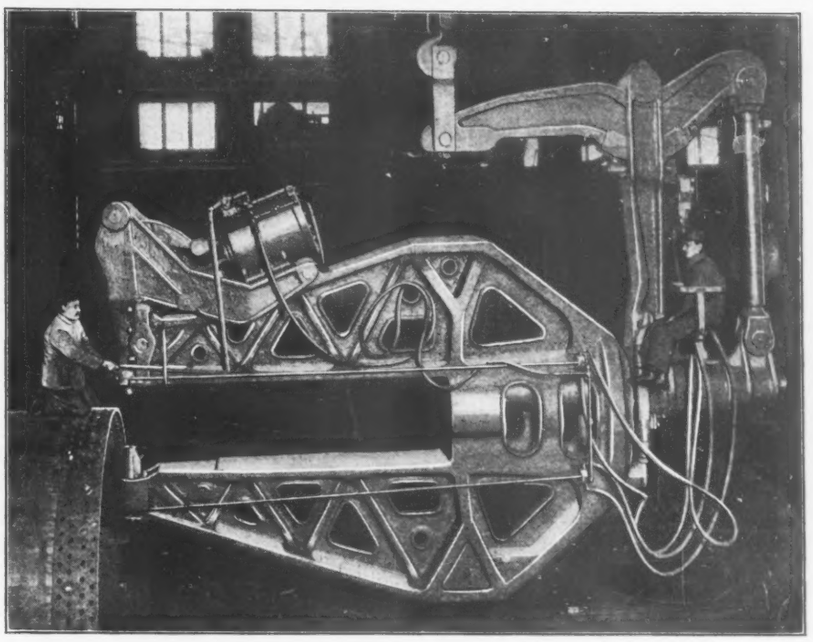
SMITH'S College Chemistry, revised and rewritten by James Kendall, Professor of Chemistry, Columbia University. The Century Company. Illustrated.

RADIO Receiving for Beginners, by Rhey T. Snodgrass and Victor F. Camp, A. I. R. E. The Macmillan Company. A short cut to mastery of the international Morse code. Illustrated.

Fix Your Own Plumbing

APPROACHING winter brings to every household the bugbear of frozen pipes and cracked plumbing fixtures. Why not be prepared?

In an article next month an expert will tell just how you can repair your own plumbing. Whether you own your own home or not, you will find it profitable to read what he says.



Largest Riveter Weighs 150 Tons

THE largest portable pneumatic riveter ever made, weighing 150 tons, has just been completed by a Chicago engineering company for use in the water power development at Niagara Falls.

This giant machine is to be used in riveting steel plates of the volute or spiral casing and penstock, or water gates, of a 70,000-horsepower hydraulic turbine. The greatest distance across the volute is 48 feet and the diameter of the water entrance is 15 feet, the plates varying in thickness from 1¼ inches to ⅞ of an inch.

The volute and penstock must be built to withstand a water pressure of 110 pounds to the square inch. Because of their immense size and weight, a portable riveter of long reach and capable of developing tremendous pressure was necessary. The huge machine designed has a reach of 118 inches, a gap of 30 inches, and exerts a force of 300,000 pounds. A shock absorber is incorporated in the drive.

The riveter is to be moved from place to place by means of a huge crane, and tilted and rotated by motors.

Quick Shave or Massage with New Vibrator

ONLY 30 seconds for a clean shave or an electric massage with the same speed and with the same instrument. Both are made possible by the invention of an electrically operated safety razor and vibrator that will be placed on the market soon by a Connecticut concern.

An electric coil inside the handle, which may be operated on any house circuit, causes the blade to oscillate with imperceptible swiftness as the razor passes over the face. The result is that the hairs of the beard are removed as though by a tiny saw, not chopped off as in the ordinary operation of shaving. Shaving with the new razor is said to cause not the slightest discomfort, no matter how tender the skin or heavy the beard.

The same coil that operates the razor also moves the vibrator when the contrivance is used for massage.

Motor-Driven Meat Saw Saves Butcher's Time

A PORTLAND, Ore., inventor has perfected a new type of power-driven bandsaw for use in meat-handling and selling establishments. It operates on a frame resembling somewhat the usual hand meat saw.

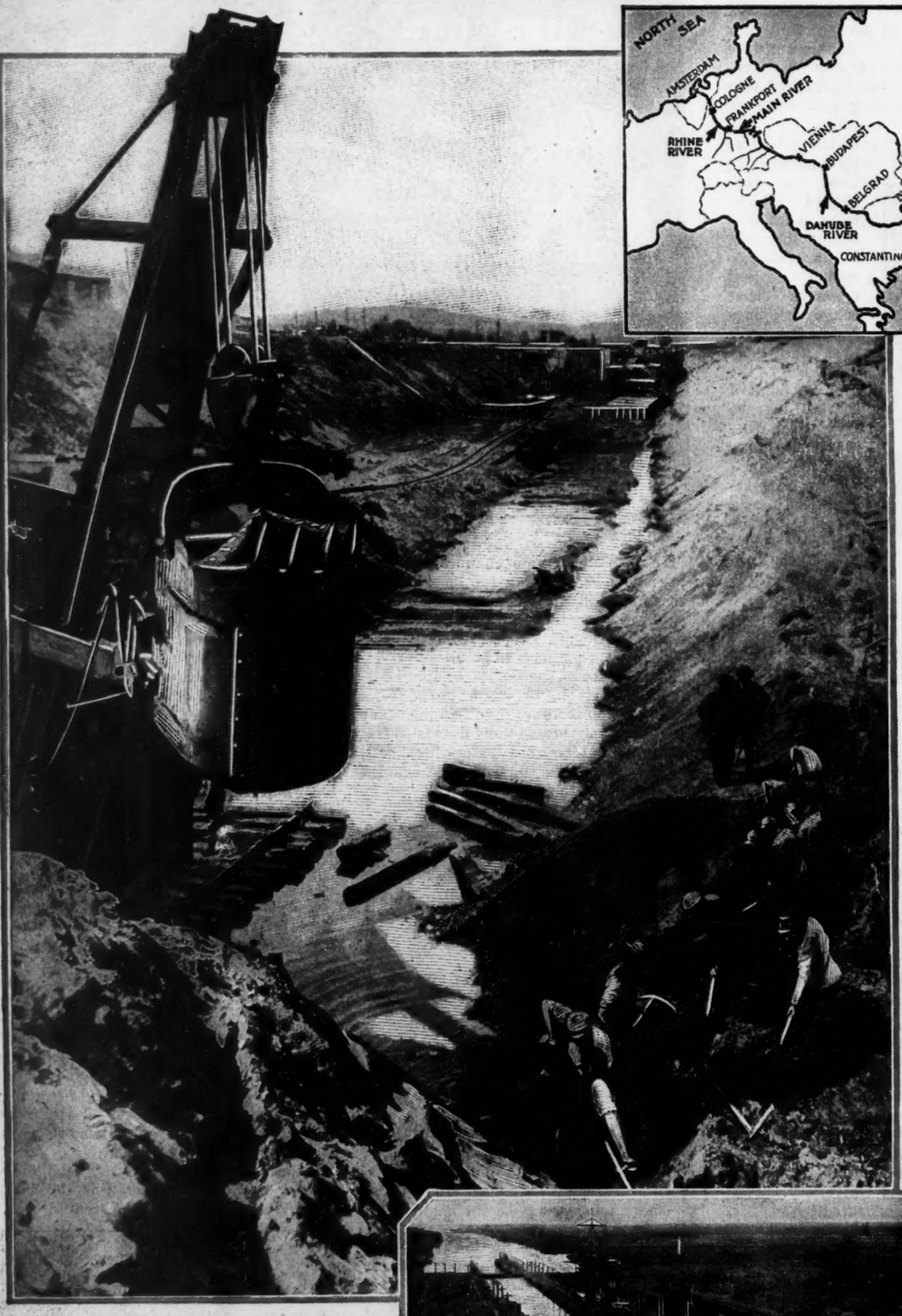
Power is supplied to the device by a flexible shaft, or directly by an electric motor mounted on the saw frame. A trigger on the handle controls the speed of the saw. The entire machine weighs less than 14 pounds, and can be used for any meat- or bone-cutting job, from cutting steaks to slitting beeves.

By an ingenious twisting of the blade of the saw, without endangering it, the size of the device has been reduced greatly.

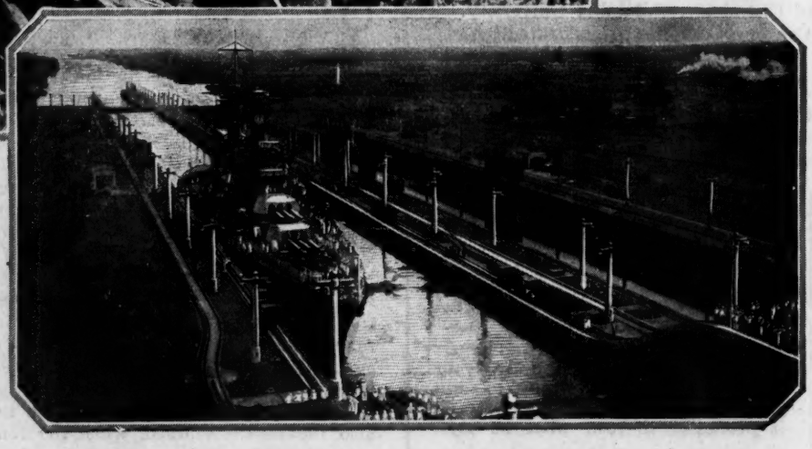
Cutting a steak with the motor-driven bandsaw, controlled by a trigger

Building a "German Panama Canal"

The map above shows the route of "the Panama Canal of Germany," linking the Rhine, Main and Danube rivers in a 1200-mile waterway from the North Sea to the Black Sea. Starting at Amsterdam, Holland, it will pass through the important cities of Cologne, Frankfort, Vienna, Budapest, Belgrad, Bukharest, Braila and Galatz



Below, a U. S. warship passing through the famous Gatun locks of the Panama Canal, with which the huge new German canal project has been compared. The photograph shows the middle and lower chambers of the remarkable locks

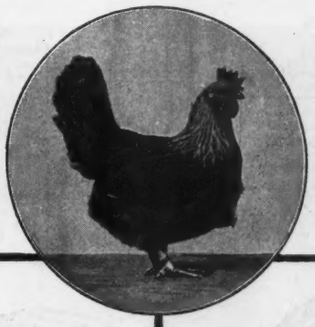


HAVING lost the all-rail line from Berlin to Bagdad, which was to have flooded the East with German-made goods, defeated Germany now is at work on the construction of a huge canal from Amsterdam, Holland, to the Black Sea at the mouth of the Danube. The photograph shows construction work on the canal.

This great enterprise—called "the Panama Canal of Germany"—will link the Rhine, Main and Danube rivers in a waterway more than 1200 miles long. Water power generated at the locks will be used in supplying Central Europe with light and power

Science Creates the Super-Chicken

White Plymouth Rock (left) contributed white plumage and egg-producing qualities. Silver gray Dorking hen (right) gave soft flesh



White plumage and production of white eggs throughout the year assured by white Leghorn (right) in the first breeding

Below: Male and female of the new Lamona breed, produced by scientific crossing of the three varieties shown above

Lamona rooster

The Lamona combines a stout body with attractive white plumage and the ability to produce white eggs the year around

Lamona hen

Here are male and female of a handsome new breed of pied chicken, by-product of the experiment

A NEW breed of chicken, made to order by science—a large, handsome fowl, with white plumage, soft flesh, and the ability to lay white-shelled eggs the year around—has just been announced by the United States Department of Agriculture.

Within a short time, the department says, the breed will be released to state agricultural colleges and through them to private individuals throughout the country. Further development is necessary in some minor particulars before this can be done, although the breed is already definitely fixed and established.

A New Breed Is Evolved

This scientific product is called the Lamona chicken. It is named for Harry M. Lamon, former senior poultryman of the United States Department of Agriculture experimental farm at Beltsville, Md. After 11 years of experiment, he has evolved the cross-breeding of three varieties of fowl.

Mr. Lamon's idea was to produce a chicken that would combine the stout, ample body desired by the butcher, with attractive white plumage and the ability to produce white-shelled eggs all through the year. Brown eggs, of course, are entirely good for eating purposes, but, probably because a white-shelled egg seems cleaner and more tempting when boiled, certain markets always have been willing to pay a premium of several cents a dozen for them.

Lamon decided upon three specific breeds to use in his experiments. He took the English Dorking for its large body and the marketable quality of its flesh, the white Plymouth Rock for its bulk and its ability to lay eggs at all times of the year, and the white Leghorn because of its white eggs.

The scientific principles upon which Mr. Lamon based his experiments were the laws of heredity laid down by Gregor Mendel 50 years ago. For many years scientists have been combining the characteristics of various plants to create new varieties; but in animal breeding, progress along similar lines has been slow. The process of making cross-breeds among live stock is complicated and difficult. For this reason the success of the experiment in producing the Lamona chicken is of intense interest and practical value to the scientific world.

In poultry, egg-producing qualities descend through the male line. For that reason, roosters of the Plymouth Rock and Leghorn breeds, known to be prolific egg producers, were mated with Dorking hens in the experiments. A close-feathered white Plymouth Rock male was mated to a silver Dorking female, and a single-comb white Leghorn male was mated to another Dorking female. The Dorking is a dark-plumaged bird with five toes.

Giving Mother Nature Some Tips

In mating the offspring of these crosses, care was taken to select only white specimens having yellow skins and four toes, and only producers of large white eggs in great quantities. As a result, unlike the Dorking, the Lamona chicken has white plumage and only four toes and produces white eggs.

As his experiments progressed, Lamon decided that his scientific chicken was to have red lobes in order to distinguish it from the single-comb white Leghorn. Poultry experts declared this would be impossible of attainment. Red ear lobes, they said, always had been a distinguishing physical characteristic of birds that produce brown eggs. Lamon, however, persisted in his attempt, and now the Lamona chick emerges from its shell with red ear lobes as a distinguishing trademark.

The Lamona chicken is actually a new breed—not merely a cross between two types. It possesses distinctive qualities, which, after 11 years of breeding and observation, appear to be fixed so firmly that the offspring will be generally and regularly true to the new type.

The weight of the chicken is between four and six pounds. The body is long and of great depth, supplying an abundance of the always desirable white meat of the breast. It is larger than the Leghorn, approaching in size American fowl such as the Wyandotte and Orpington. It is well feathered, a fact that makes it unlikely that it will be affected by sudden changes of temperature and augurs well for its ability as a layer of winter eggs.

Pied Birds a By-Product

An interesting by-product of the experiment was the development of a handsome pied breed, the females having pale buff breasts and the males being white with rich red wing bows and red backs. Some of these lay white and some tinted eggs. They have not been so well developed as the Lamona, but further experiments with them probably will be made because of their beauty. If this is done, the first thing to be attempted will be the intensification of the color of the females.

Similar to the experiments that produced the Lamona chicken are those undertaken by Z. T. Spencer, a man of 75 years, living near Santa Cruz, Calif., who has successfully crossed a Rhode Island Red hen with a small white Holland turkey, producing an interesting hybrid which he calls the Spencer Turken.

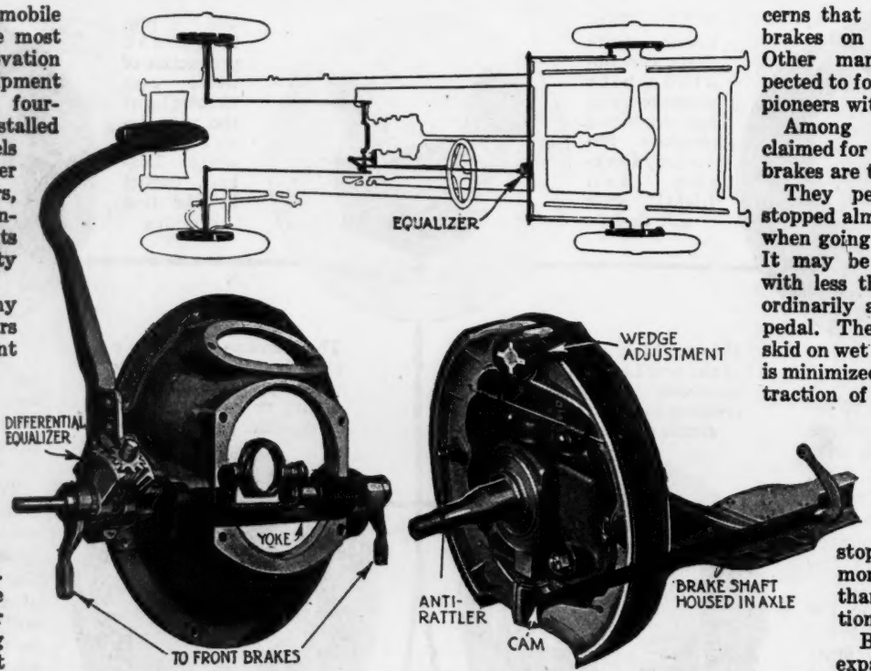
This new fowl, the breeding of which has progressed to the fifth generation, is fleshy, its meat being a sort of blend of chicken and turkey. It is heavy in the legs and in the breast, and it produces large brown eggs, which hatch in 23 days. The family is extremely hardy, their greater physical resemblance being to the chicken.

The experiments have occupied a period of four years, and experts say that seven generations of breeding will standardize the breed both in type and color.

Greater Safety with New Four-Wheel Brakes

HAILED by automobile engineers as the most important innovation in automotive equipment since the self-starter, four-wheel brakes will be installed on forthcoming models of several of the larger makes of American cars, and their ultimate general adoption as agents of efficiency and safety is freely predicted.

For several years many makes of European cars have carried both front and rear wheel brakes. But American automobile engineers, although recognizing certain obvious advantages, were slow to adopt them because of certain problems connected with their use. Principal among these was the necessity for supplying less braking power to the front wheels than to the rear. If this were not done, the front wheels were likely to lock when the brakes were applied suddenly, making it impossible to steer the car. It was also necessary to furnish the front wheels with differential gearing to equalize the difference in traction between the right wheel and the left on turns.



Top: Chassis with the new brake. Left: Clutch housing supporting front wheel operating yoke. Note differential equalizer in bottom of pedal. Right: Front wheel brake drum. Note holes for escape of moisture expelled by centrifugal force

These problems and others are said to have been solved satisfactorily by the concerns that will offer four-wheel brakes on their new models. Other manufacturers are expected to follow the lead of these pioneers within the next year.

Among the advantages claimed for these new four-wheel brakes are the following:

They permit a car to be stopped almost in its own length when going at 30 miles an hour. It may be brought to a stop with less than half the pressure ordinarily applied to the brake pedal. The tendency of a car to skid on wet or slippery pavement is minimized because the relative traction of the wheels is maintained at the same ratio when the brakes are applied as when the car is proceeding without brakes. Ordinary stops are accomplished more smoothly and easily than with the conventional rear-wheel brakes.

Brakes of the internal expanding type are favored in America for front-wheel control.

American cars, manufacturers say, are generally sold on a basis of price rather than of performance. Those who are developing the four-wheel brakes, however, think that price is secondary to comfort and safety.

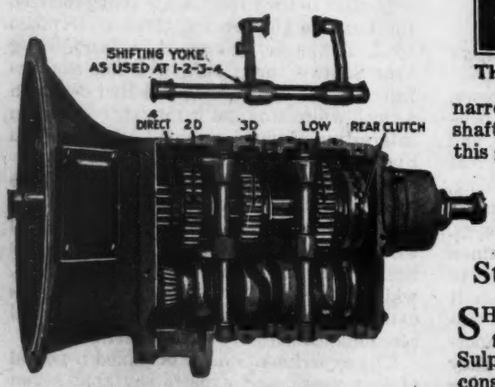
Transmission Stops Gear Stripping

BY THE installation of a new automatic transmission, it is possible to shift from one gear to another, reverse included, regardless of the speed of the car. If the brakes fail to work, the driver may engage reverse, using the engine and a gentle application of the clutch to stop the car. Gear stripping is impossible because the driveshaft is automatically disconnected when gears are being shifted.

A selector quadrant and wheel directly below the steering-wheel replace the usual gearshift lever and gears are shifted by moving this wheel after the clutch pedal has been depressed.

In the four-speed transmission, the countershaft is placed under the main shaft, and the cam shaft is located to one side of the main shaft. One complete revolution of the cam shaft meshes every gear in succession, reverse to fourth, and while each gear is being meshed, a special cam at the rear releases a dog clutch on the tail end of the main shaft, thus disconnecting the main shaft from the propeller shaft.

Fourth gear is engaged by sliding second gear ahead until it meshes internally with a narrow gear on the rear end of the clutch shaft. Second gear is engaged by moving this gear to the rear. Third gear is meshed by moving it forward. First gear is moved forward to give low and to the rear to give reverse.



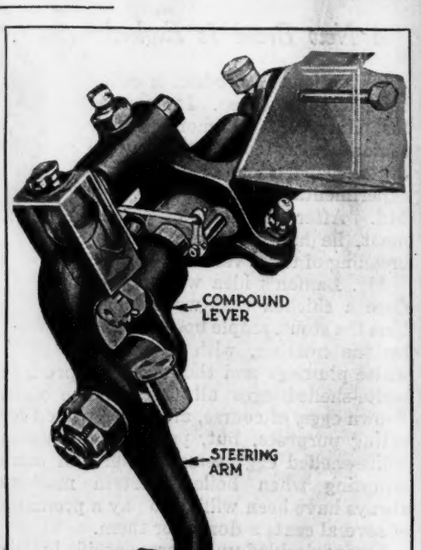
Illustrating how one revolution of the cam shaft meshes every gear in succession from reverse to fourth

The selector quadrant and wheel used

Straw in Steering Wheels

SHREDDED straw is an important ingredient in a Ford steering wheel. Sulphur and rubber are the other principal constituents.

This straw comes from a farm that is a part of the plant that manufactures the steering wheels.



New Compound Lever Makes Ford Driving Easier

ADDITIONAL steering leverage for Ford cars is claimed to be obtained by substituting this compound lever for the original single lever. The device may be installed in about half an hour. It is said that it prevents the steering wheel from being jerked from the hands on rough roads and gives complete control in turning around, backing up, and turning corners sharply. It is claimed to prevent the front wheels from locking under the car.

What the Balloon Tire Offers You

Because of its thinner, more resilient walls and lower air pressure, the new balloon tire above is less likely to be damaged by contact with the sharp curb

At the left: The tread imprint of a 7.30 balloon tire with 35 pounds air pressure, as compared with that of a 33 by five-inch high-pressure pneumatic with 65 pounds pressure. Note increased contact with the road

ANOTHER distinct advance in tire development—the balloon tire—promises in preliminary tests to offer, when perfected, an even more epochal boon to the motorist than did the cord tire. The distinguishing characteristics of the new design—also known as the doughnut, air cushion, or supercushion tire—are larger cross section and thinner walls than those of the standard tires of today.

In this novel type of construction the underlying purpose is to permit riding on a lower air pressure, thus making the car ride much easier, reducing vibration with accompanying wear and tear on the car's mechanism, and at the same time providing greater comfort and safety for motorists. Experiments by several of the large tire companies already point to its eventual success.

It is a law of tire physics that the larger the area of contact with the road the less is the air pressure required for any particular weight of car. Designers who are working on the balloon tire believe that the high pressures of ordinary pneumatic tires convey to the car and its occupants an unnecessarily large proportion of each road shock, just as does any rigid connection. Hence, the balloon tire is so constructed that it can be used considerably deflated, with air pressure of only 35 pounds, or even still lower.

The ordinary tire is designed for high pressures. Deflation tends to separate the tread and plies. Moreover, the walls, thick to withstand high pressures, tend to bend along one rather narrow line, just as a piece of cardboard bends more sharply than a piece of writing paper. This tendency is destructive to the tire wall.

The lower pressure in the balloon tire permits thinner and differently constructed walls, which bend less sharply and hence are more durable at low inflation.

The designers concede that thus far the balloon tire is little more than a promising experiment. Yet the enthusiastic unanimity with which one group of experimenters—six taxicab drivers—recently testified to the shockless riding of the new tires is impressive. Each ran his car about 4000 miles with them. They reported that all road irregularities such as the ordinary tire would convert into distinct shocks, to the discomfort of passengers and the harmful jarring of the mechanism, either were smoothed out remarkably or completely eliminated.

These results, of course, were to be expected to some degree. Automotive experts long have recognized that high pressure makes the air in tires less yielding. They have clung to high pressures because they believed that partial deflation necessarily was destructive. But only two blowouts occurred during comprehensive tests with the balloon tire, indicating not the slightest damage from partial deflation.

It was found that the new tires accommodated themselves, because of their air content and thin walls, to the irregularities of the road. Crossing tracks, for example, was found to deflect the wheels scarcely at all, even when the car was running nearly parallel with the rails. In one test a car actually was driven down a railroad bed over the ties, with surprisingly little discomfort to the passengers.

Superior responsiveness to brakes and comparative freedom from skidding also are claimed for the new tire. The larger area of contact holds to the road better when a sudden stop is necessary or when slippery pavements make steering difficult. Moreover, hill-climbing is said to be easier and surer because of better road contact.

Probably this securer contact, which explains the superior hill-climbing, anti-skid, and brake-responsive qualities claimed for the new tire, explains also the somewhat smaller gasoline consumption recorded by the test cars. Apparently each revolution of the rear wheels gave greater impetus and less slippage to the car than is possible with the usual type of tire. The mileage to the gallon attained by the test cars averaged 13.5. That achieved by a group of cars engaged in similar service and equipped with cord tires was 12.6.

The striking freedom from punctures and blowouts demonstrated in the tests of the new tire is attributed to its low air pressure. The makers believe that low inflation makes the tire yield somewhat to any sharp object.

Against these striking advantages claimed for the new tire are a few conceded defects, including unsteadiness of the front wheels and a "galloping" motion that affected all the test cars not equipped with snubbers or shock absorbers. Another disadvantage is that the tire, because of its large contact area, throws an astonishing quantity of dust and mud.

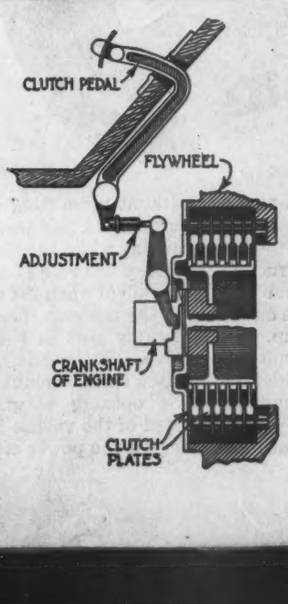
But while the balloon tire is still in its experimental period, its essential principles seem to have vindicated themselves. Inventive genius undoubtedly will find a way to circumvent its disadvantages.

Know Your Car

The Clutch

THIS is a device that connects and disconnects the engine and transmission so that the car may or may not move while the engine is running.

The multiple disk type clutch is illustrated here. There are two chief parts, one part attached to the crankshaft; the other to the transmission. Each has a series of disks or plates so arranged that they engage one another by friction when the clutch is "in," causing one series of plates to drive the other. When the clutch is thrown out, the parts are separated and the engine can run without having any effect upon the car.



Oil Transmission Replaces Gears

Single Lever Controls All Speeds and Applies Brakes in Remarkable New System

AN ENTIRELY new system of oil transmission for automotive vehicles, invented by two engineers of Grand Rapids, Mich., is designed to eliminate the clutch, driving shafts, gears, and brakes. A single lever controls all forward and reverse speeds as well as serving to apply the brake and to disengage the engine for idling.

The transmission system consists of a pump connected directly with the power shaft of the gasoline engine; two motors connected with the two driving wheels of the car and driven by oil circulated by the pump; an ingenious valve controlling the flow of the oil, and a number of pipes that conduct the oil from the pump to the wheel motors and return.

VALVE PORTS FOR "AHEAD"
VALVE PORTS FOR "REVERSE"
VALVE PORT FOR "IDLING" AND TO SET BRAKES
VALVE PORT FOR "IDLING" AND VALVE FOR RELEASING BRAKES AND FOR COASTING

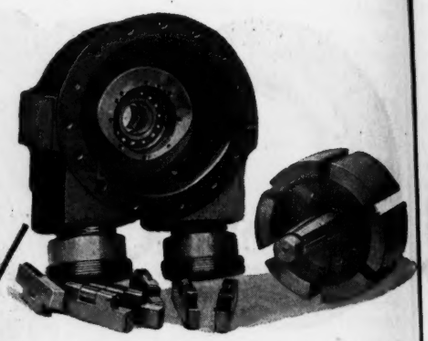
The grooved cylindrical core and housing of the transmission control valve are shown at right. Above are operating positions of the valve ports for going ahead, reverse, idling, braking, and coasting. Speed variations depend on the valve opening

A circular disk, eccentrically mounted in the elliptical pump chamber, has six slots in its circumference that contain rectangular sliding bars. As the disk rotates, these bars are forced against the inner surface of the chamber by a cam, each pair of bars forming a space the size of which changes as the mechanism turns. As the bars are moved away from the oil inlet in the pump, the space becomes larger, thereby drawing oil into the pump. When the bars approach the outlet, the space becomes smaller, forcing out the oil. In this way a continuous flow of oil through the pump is maintained.

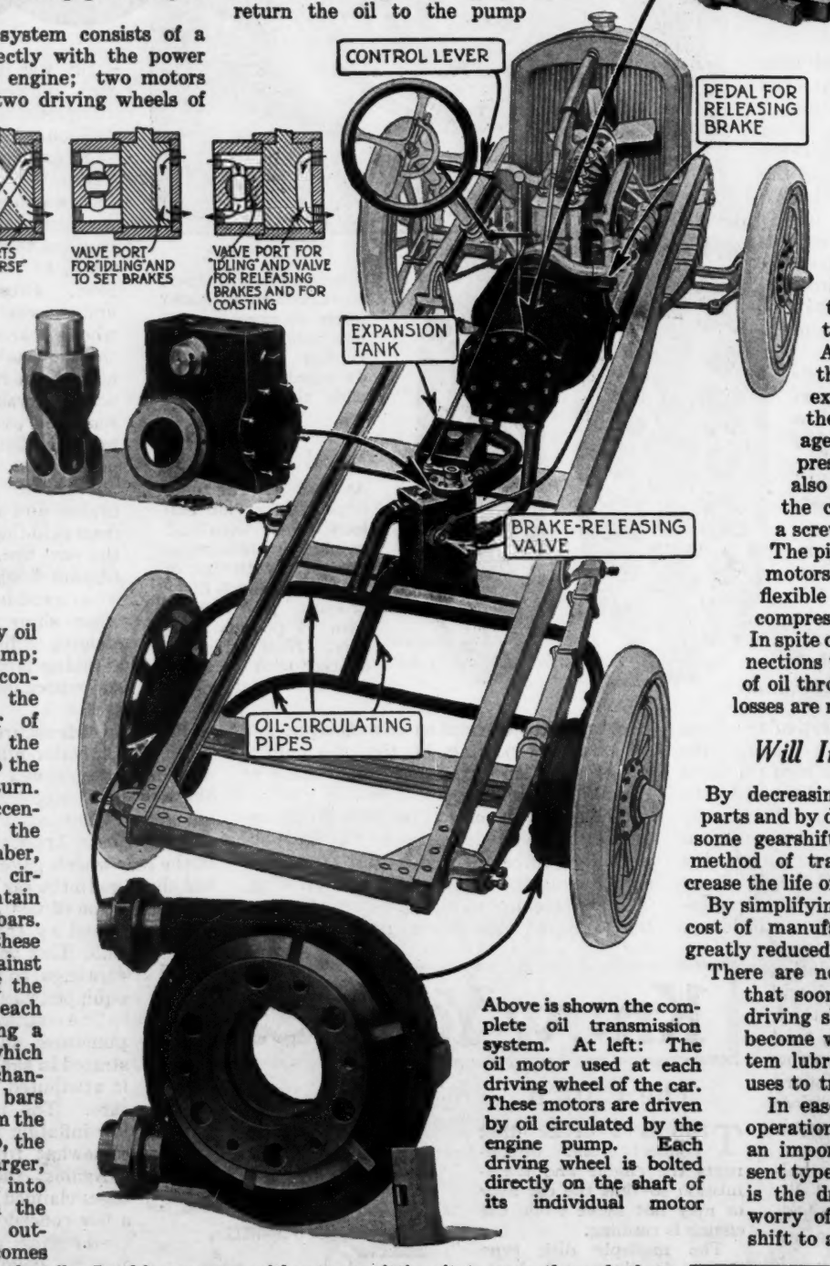
The motors are similarly constructed, operating under the pressure from the pump, the oil being discharged at the outlet and being sucked back into the pump.

A control valve, placed in the circuit between the pump and the motors, consists of an adjustable cylinder containing a number of slots and grooves, the position of which determines direct flow, reverse, and for bypassing the oil when idling. When the cylinder is turned so that two holes in it lie exactly over the inlet and outlet pipes, the oil passing through exerts forward pressure on the motor. Two spiral cuts around the cylinder serve to lead the oil into the return chamber of the motor, causing the rotor to reverse. A single axial groove is used to return the oil to the pump without permitting it to pass through the motors. In this way the motor can be left running while the car is stationary.

Since the rate of turning of the motor is dependent upon the pressure exerted by the oil, the medium speeds can be obtained by blocking part of the oil by means of the valve. By partially opening the valve, only a small amount of oil can pass, and as this opening is gradually widened, the speed of the vehicle is increased. By shutting off the power completely while the car



Above is the oil-circulating pump, driven by the auto engine. It is directly connected with the engine shaft, as indicated by arrow, and always runs in tune with the engine



Above is shown the complete oil transmission system. At left: The oil motor used at each driving wheel of the car. These motors are driven by oil circulated by the engine pump. Each driving wheel is bolted directly on the shaft of its individual motor

is running, the motor acts as a pump and thus, since the oil is blocked, the system acts as a brake.

A vented tank is inserted in the oil system to allow for expansion and contraction of the liquid and external leakage, as well as to relieve the pressure on the return pipe. It also allows an escape for air in the circuit and is provided with a screw cap for filling the system. The pipe sections extending to the motors on the wheels are made of flexible steel tubing to allow for compression of the chassis springs. In spite of the flexibility of these connections there is no appreciable loss of oil through them and the pressure losses are negligible.

Will Increase Auto's Life

By decreasing the number of moving parts and by doing away with the troublesome gearshifts, it is claimed that this method of transmission will greatly increase the life of automobiles.

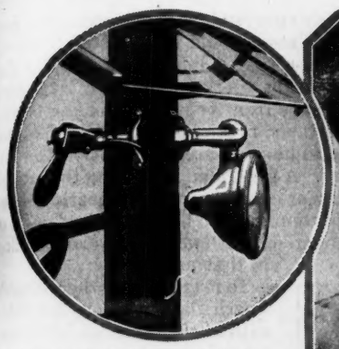
By simplifying the structure, the weight, cost of manufacture, and upkeep will be greatly reduced, the designers assert.

There are no brakes to require linings that soon wear out. There are no driving shafts or universal joints to become worn out. Finally, the system lubricates itself with the oil it uses to transmit the power.

In ease, simplicity, and safety of operation, the system is said to be an important advance over the present types of transmission. Not only is the driver freed of the constant worry of gear stripping, but he can shift to any speed with one lever.

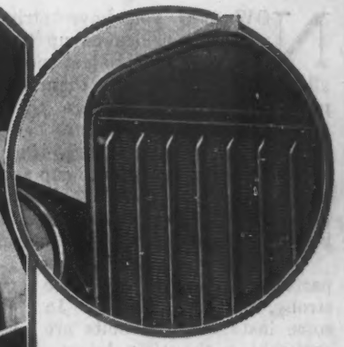
IN EVERY section of the United States where the seasons are extreme, the coming of winter invariably brings with it a curse to the auto owner. A helpful article in next month's issue will tell how to prepare and care for your car so that winter driving will become a pleasure rather than an experience to be dreaded.

Useful New Accessories for the Auto Owner

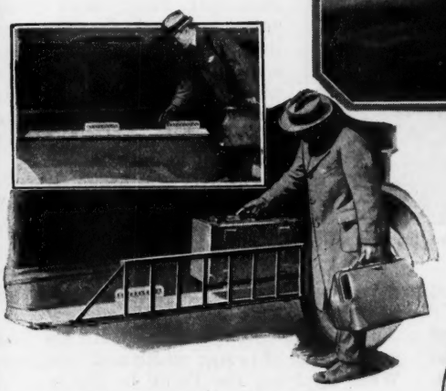


Controlled from behind the windshield, this unusual spotlight is pivoted to cast a brilliant beam of light in any direction. It holds its position on the roughest roads

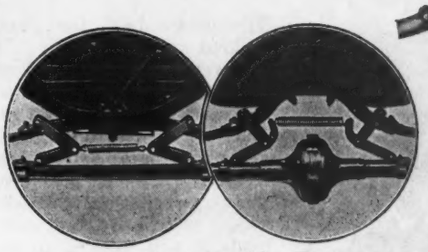
Lighting cigar or cigarette with one hand while driving a car is simplified by an ingenious electric heater attached to the dash lamp socket. Pressure on a contact plug at the top of the device lights an electric coil



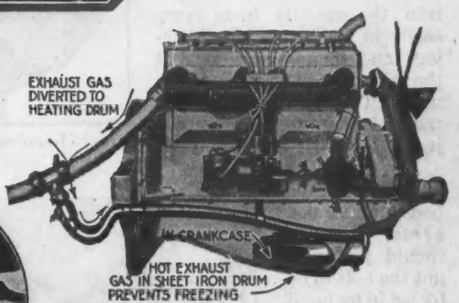
Many a radiator has been bent or broken by collision with another car. This new protector, consisting of a series of steel bars, saves the radiator while providing sufficient air space for cooling



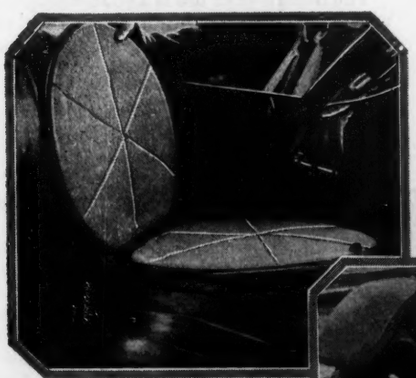
A disappearing grip rack for the runningboard folds into an inconspicuous metal strip that edges the board when the rack is not in use. When unfolded upward, it becomes a sturdy metal frame held firmly by bolts. Slots are provided for straps to bind luggage tightly to the frame of the rack



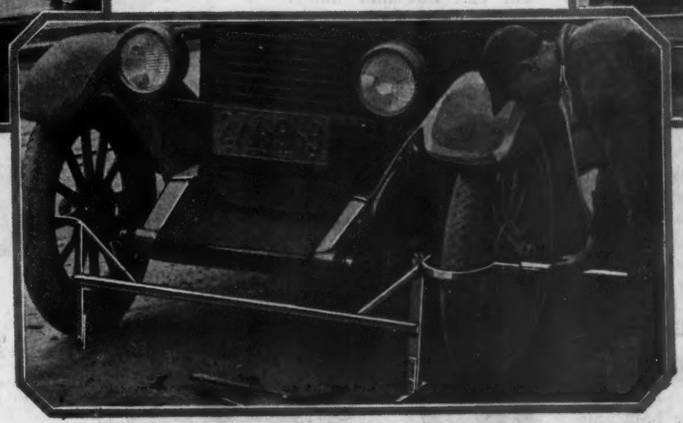
A new shock snubber for Ford cars consists of two levers, the lower ends of which are bolted to the front or rear axle, the upper ends connected with a spring. Both levers are attached to the springs of the car through toggles



Freezing of oil in the crankcase is prevented by this exhaust heater. Moist vapors that get by the piston rings pass out through the breather pipe instead of condensing into water and mixing with oil. Hot exhaust gas is passed through a sheet-iron drum introduced into the front of the crankcase



With the simple gage shown below, the motorist can tell instantly whether his car wheels are out of alinement. The stop is placed against the inside felly of one front wheel. The curved portion on the opposite side straddles the opposite wheel. A gage rod then is run against the outside felly and a reading taken with a rule



This novel motor cushion for the driver is made of an 80-foot coiled spring, wound spirally and covered closely with a woven textile. It gives not only a cushioning effect, but provides air space that prevents perspiration on a long drive. When not in use, it folds into a flat cylindrical shape

Road shocks are absorbed by a cushion of air in this bell-shaped absorber that consists of an inflated air chamber sealed by a flexible diaphragm rocking on a vertical arm. The diaphragm extends from the axle and forms the connection between axle and spring. The absorber is inflated occasionally like an auto tire

How to Rebuild a Broken-Down Car

By Ray F. Kuns

Principal, Automobile Trade School
Cincinnati, Ohio

THE third and last article in this series on overhauling used autos will appear next month. In it Mr. Kuns tells in detail just how to reassemble the engine and repair the ignition, accessories, body, and top.

NOW that you have stripped the frame and cleaned up the chassis units, as outlined last month, sound all the rivets by tapping them with a ball peen hammer and replace those found loose. If you lack the tools necessary to insure a good job of hot riveting, enlarge the old rivet holes to take cap screws and nuts. A 5/16-in. rivet hole is enlarged to take a ⅜-in. bolt, and other sizes may be used in proportionate measurements.

When bolting the frame parts together, always use strong, new lock washers. In some instances, the bolts are preferable to the original rivets.

Stretch stovepipe wire tightly from the center of the front cross member to the center of the rear cross member of the frame, making measurements from this wire to see that the frame is straight and true. If it is sprung downward or sidewise, use chains and jacks to pull it back in place.

Bushings in the front axle and steering gear must be snug. New bushings can be pressed into the spindle body very easily in the vise. The bushings must then be reamed to fit the pin or bolt that is to be used. This operation is illustrated in Fig. 3, where an adjustable reamer is being used.

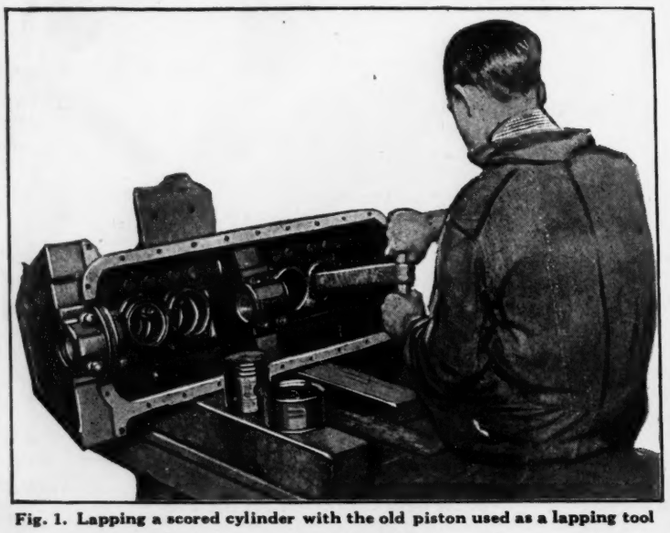


Fig. 1. Lapping a scored cylinder with the old piston used as a lapping tool

For bushings in the spindle body and tie rod arms, the fit should just permit the bolt to be forced in by hand or with a light blow. For spring bushings the fit might be a trifle looser and for piston pin bushings, the pin should be tight enough so that it can just be forced in by hand.

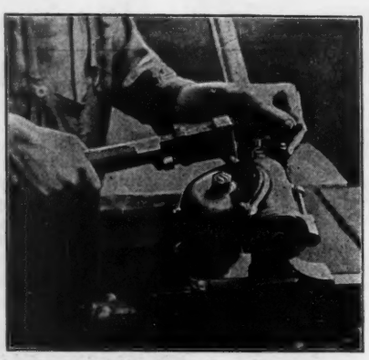


Fig. 2. Adjusting the thrust on the worm of the steering worm gear

When reassembling the steering gear and front axle, special care must be taken to see that a proper fit is provided for all moving parts. The wheel bearings should fit so that the weight of the valve cap on the tire will cause it to seek bottom. Make certain that no dirt gets into the bearings and pack them in cup grease. See that all oiling devices are in good condition. If an old system of cups is in use, it will pay to discard them and substitute a pressure grease gun.

The method of adjusting the thrust on the worm of the steering worm gear is indicated in Fig. 2. It should be sunk enough to prevent end play on the worm shaft and yet not allow the thrust bearings to bind.

When the springs are reassembled, the shackles are made tight enough to prevent any play, but not so tight that they grip the spring end rigidly. When the shackles are too tight, there is a disagreeable chirp as the car passes over road bumps, and in bad cases the master leaf of the spring will be broken. The spring clip nuts must be made quite tight; after the car has seen a little service they must again be tightened. This will prevent breaking at the center bolt hole. The center bolt, too, must be kept snug.

In repairing the rear axle of this particular roadster, it was necessary to remove and replace the old ring and pinion gears with new ones. When riveting a ring gear in place, it is necessary to proceed as in Fig. 4. A mistake commonly made in this work is to attempt to rivet the gear to the differential housing without first bolting the parts rigidly together with three or four equally spaced cap screws. This results in the far edges separating as the first rivet is drawn down, and frequently separation cannot be overcome entirely, with the result that the gears always growl.

When adjusting the ring and pinion, allow a barely perceptible amount of backlash. If too much is allowed, the assembly is weak and noisy; if too little, the axle will run hot and noisy. A good method of adjusting these gears is to use red lead for checking the contacts. These should be adjusted until the red lead shows a line of contact the full length of the tooth rather than a tapering spot on the front or rear end of the teeth.

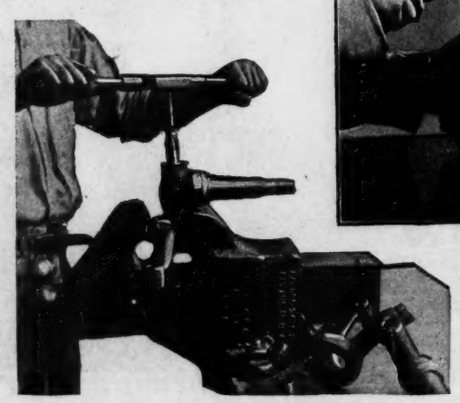


Fig. 3. (At left) Reaming a new bushing. Fig. 4. (Above) Riveting the ring gear in place

The taper roller bearings should be adjusted to have a barely perceptible amount of play. A good plan is to bring the adjusting ring or collar up until the bearings show a slight tendency to bind and then back off the collar one or two notches and lock it in that position.

In reassembling the rear axle, watch the provisions for lubrication. See that all felt grease retaining gaskets are new and properly installed. Take particular pains to see that the grease can not work out into the brake drums and lower the efficiency of the brake.

Make new gaskets for the axle housing inspection plate and the differential carrier mounting. Heavy brown paper may be used for this, but every particle of dirt and remnant of the old gaskets must be removed. Rim and gasket shellac or cup grease may be used to help make the joint snug and leakproof.

Go over the brake mechanism carefully and rebuild all worn parts. Where pins are worn in the brake clevices, the holes are drilled out for larger pins, which may be made from cold rolled rod with a cotter key in each end.

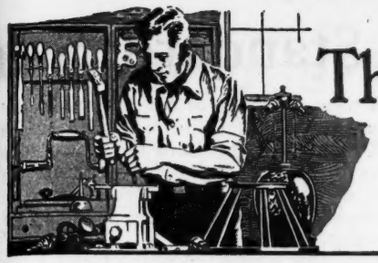
Brakes should be relined with the best grade lining of proper width and thickness. When applying the lining to the internal expanding bands, little trouble is experienced, but there is always a tendency to cut the lining over the external bands too short so that it will have flat sections. To prevent this, allow about ¾ in. more than the apparent length and then rivet each end. After the ends are secure, the buckle is hammered out or forced to lie against the inside of the brake band. This insures a good fit and the riveting may then proceed.

The best rivet to use is a solid copper one with a long tapered head, rather than the flat head or belt rivet, or even the split rivet. Never use iron rivets, as they will cut the brake drums and are sure to give a noisy brake. The heads of rivets are always carefully countersunk so that they do not come in contact with the brake drum. Set the rivet head on the end of a punch while riveting up the burr.

When adjusting the brakes, set them up until there is 1/64 in. space under the band at every point. New bands or linings must be run in before final adjustments can be made.

Transmissions, as a rule, give little trouble, but it is well to pull the gears and inspect all bearings and shafts. You may find the second-speed gear tapered or broken, since this is the one that most often makes trouble. It is

(*Turn to page 108*)



The Home Workshop

Arthur Wakeling, Editor

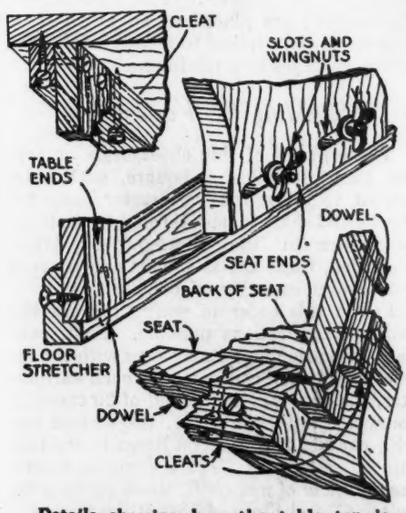
Build a Child's Pullman Play Table

NOTHING pleases the kiddies so much as to have a play table of their own, just made to suit them, with comfortable seats and a drawer to keep their picture books, crayons, cutouts, and other small belongings.

The table illustrated is especially designed to meet their needs. Built like a miniature of a "grown-up" Pullman dining alcove, it has a fascination for children far in excess of any ordinary small table, and they will spend many happy hours playing at it during the late fall and winter months, when stormy weather forces them to stay indoors.

Simple and sturdy of construction, the table can be constructed quite easily even by home workers who have not had much experience in handling woodworking tools, and the expense for lumber is small. This makes it an excellent project to be constructed as a Christmas present—much more so than the average toy, because it has real utility and can be made most attractive by careful finishing and decorating. Whitewood or pine may be used if the table is to be enameled, or cypress if it is to be stained and varnished.

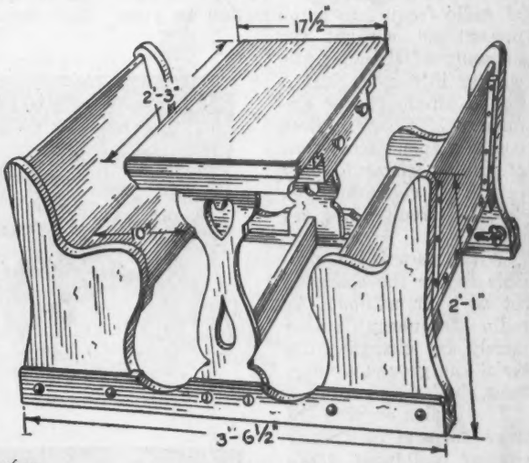
The parts are set up on two rabbeted stretchers, 1¾ by 3½ in. by 3 ft. 6½ in. The table ends, ⅞ by 8½ by 22⅞ in. over all, are fastened to the center of these floor pieces with dowels and screws, and are braced by a foot rail or stretcher. The seat ends, 1⅛ by 14½ by 24 in., are slotted, so that the seats can be adjusted back and forth, as found most comfortable, and fastened with wingnuts.



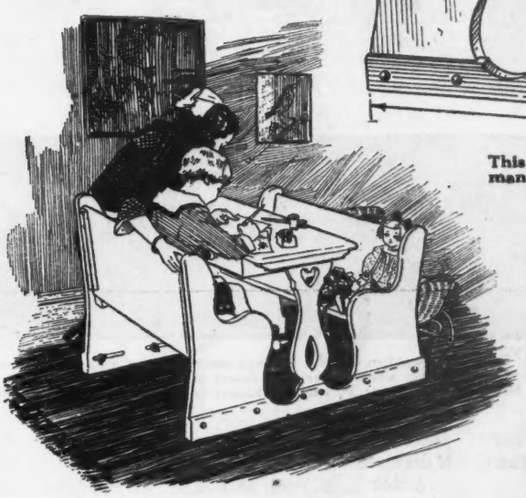
Details showing how the table top is fastened and the seats are put together

At the top the table ends fit into recesses cut in the 1¾ by 1½ by 16½ in. top cleats or rails, and to these rails is screwed the top, which is 1⅛ in. by 17½ in. by 2 ft. 3 in. One large drawer, 18 in. wide, 16½ in. long and 3½ in. deep, is hung on cleats under the table top and slides out in either direction. This makes it impossible for the children to spill the contents, and the drawer itself can be divided inside if desired.

The seats are of equally simple construction. The backs, ⅞ by 14½ by 23 in., and the seats, ⅞ by 10 by 23 in., are doweled into the ends and reinforced by cleats.



This play table, which is a miniature Pullman dining alcove, delights the kiddies more than many elaborate toys



The whole play table is narrow enough so that it can be carried through any ordinary doorway, and it can therefore be moved from room to room or taken out on the porch or lawn in the summer.

The ideal way to finish the play table is to enamel it some light color and decorate it with nursery figures or animals in bright colors. These decorations can be hand-painted in oil colors, transferred with decalcomanias, or cut from picture books, cemented in place and varnished.

The table was especially designed for the Home Workshop by George F. Kaercher, of Philadelphia, for many years a furniture factory superintendent and designer. The idea was suggested by Mrs. H. A. Smith, of Dexter, Ia.

Full working details of the table, and a complete bill of materials are contained in Blueprint No. 28, which will be sent for 25 cents. Address Blueprint Service Department, Popular Science Monthly, 225 West 39th St., New York.

Making a Galloping Merry-Go-Round

MUCH more fun than the ordinary home-made merry-go-round is this galloping carousel. It gives an eccentric up-and-down motion.

Cut the plank in three pieces, the center piece being square, and bevel the cuts so that when the pieces are hinged together the end lengths can move up and down in relation to the center. Four heavy T-hinges are placed on the under side of the joints. The central support can be an old stump or a wooden block set in the ground.

The seesaw motion is created by two wheels pivoted eccentrically to the ends of the plank, turning on bolts or lag screws set 4 in. off center. The wheels are of two layers of 1-in. lumber about 3 ft. in diameter.—D. R. V. H.

Eccentrically mounted wooden wheels give an up-and-down motion to the hinged ends of the merry-go-round plank here illustrated

Adding Radio Frequency to a Standard Set

By Joseph Calcaterra
Of Popular Science Monthly's Radio Staff

DISTANCE, more distance, and still more distance is the goal of the average radio fan. The ability of a set to reach for distant stations can be increased greatly by the addition of two or three stages of radio frequency amplification.

By following the instructions given in this article it is possible to add three stages of radio frequency amplification to your present set without the necessity of changing the wiring, if the set has a double circuit tuning element. If your receiver uses a single circuit type of tuning element, only two minor changes of the detector circuit wiring are necessary.

With this unit it is possible to use the complete set with or without the radio frequency stages merely by changing the aerial and ground connections.

The unit consists of three stages of variometer coupled and tuned radio frequency amplification. By its use stations more than 1000 miles away are brought in easily.

The general layout of the panel and instruments can easily be seen from Fig. 1. The panel can be made of any approved panel material and should be 24 by 7 by 3/16 in.

In order to avoid confusion in wiring, all the parts have been lettered so that the wiring can be traced from point to point.

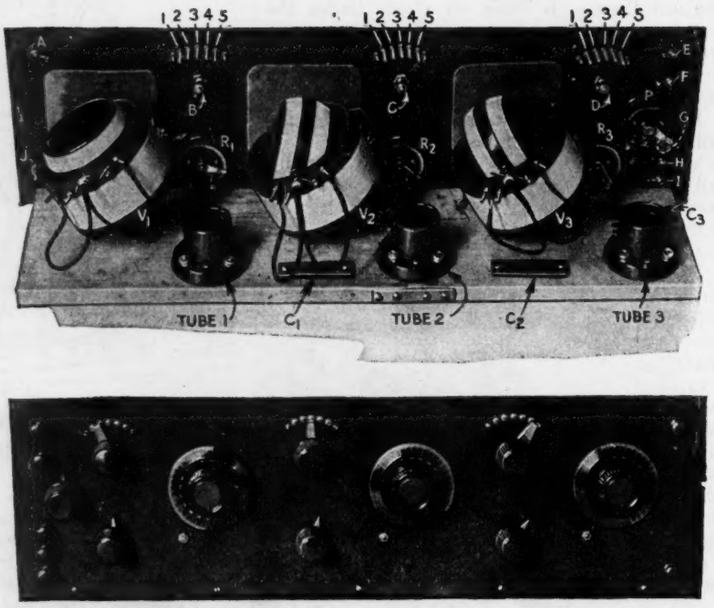


Fig. 1. The location of the various parts of the radio frequency unit are shown in the above rear and front views. Terminal G is hidden by the potentiometer P, but its location is shown by the dotted line

Wiring the Unit

A, *J*, *E*, *F*, *G*, *H*, and *I* are binding posts. *A* and *J* are the aerial and ground terminals respectively. *E* and *I* are the posts that are to be connected with the aerial and ground posts of your present set. *F* is the B battery binding post; *G* the positive A battery terminal. In the upper view the terminal G is hidden from view by the potentiometer, but its position is shown by dotted line, and can easily be seen. *H* is the negative A battery connection.

B, *C*, and *D* are the tap switches for varying the number of turns or inductance of the variometer stators. These tap switches are desirable but not absolutely necessary. If standard variometers with large size rotors are used in place of the homemade variometers, no tap switches are necessary.

R_1, R_2, and R_3 are the rheostats that control the filament current of their respective tubes, 1, 2, and 3.

V_1 is the variometer that acts as the tuning element of the receiver. V_2 and V_3 are the other two variometers made in the same manner as V_1 and furnish the coupling between the first and second and the second and third stages. The coupling between the third stage and the detector stage is furnished by the tuning elements of the standard receiver with which the unit is to be used.

P is a potentiometer of 200 or 400 ohms and is used to adjust the proper operating potential on the grid of the first tube.

C_1, C_2, and C_3 are fixed condensers of .001 mfd. The first two are used between the variometers and the grids of the succeeding tubes, while the last is used across the movable arm of the potentiometer and the negative A battery lead.

The photograph of the variometer (Fig. 2) shows the details of construction of this instrument so that long explanations for its building are not necessary. The stator tube should be four inches in diameter and three inches long. The rotor should have a diameter of about 3½ in.

A slot ⅜ in. deep and ¼ in. wide is filed at the top of the stator tube to receive the front end of the rotor shaft. A similar slot is filed at the opposite point of the stator to receive the rear rotor shaft. Several fiber or metal washers slipped on the front and rear shafts of the rotor and placed between the rotor and stator will center the rotor and provide the required friction to hold the rotor wherever adjusted, if the washers are of such thickness as to spring the stator tube slightly. The fiber washers used in faucets will answer the purpose.

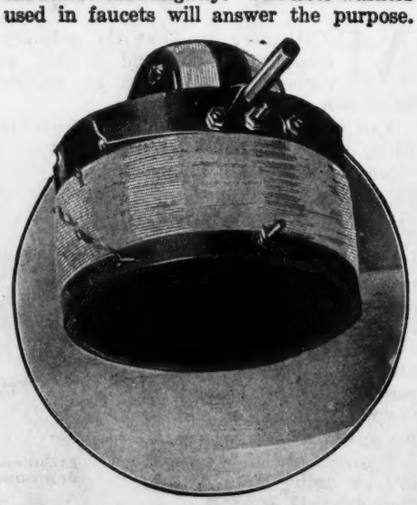


Fig. 2. Constructional details of the variometers are shown in the above illustration

A piece of No. 18 or No. 20 wire looped over the shaft and anchored with screws and nuts projecting from the stator tube serve to hold the rotor in place. At the rear of the rotor one of these screws is allowed to project and serves as a stop for the rotor.

Two other screws projecting through the front of the stator tube and held in place by nuts provide means for fastening the variometer to the panel. The top screw can be placed about ⅜ in. below the center point of the rotor shaft bearing slot, while the other can be inserted about ⅜ in. from the bottom end of the tube. Care must be taken that these screws are placed directly below the shaft center line, as otherwise difficulty will be experienced in mounting the variometer on the panel. About two nuts should be threaded on each screw to keep the variometer a short distance from the panel.

The stator should be wound with 60 turns of No. 24 single or double cotton covered wire. A tap is taken at the twentieth turn from the top and four more taps are taken at every 10 turns.

The rotor may have from 30 to 60 turns. Any rotor wound full with No. 24 wire will do.

The shaft hole for V_1 is drilled 2¾ in. from the top and 3 in. from the side of the panel. The other variometer shaft holes are drilled 7 in. from each other. The axes of the variometers are placed at an angle of 30 degrees to the vertical to reduce interaction between stages to a minimum.

Shielding the Variometers

Three pieces of thin sheet brass or copper about four inches square, with holes spaced to allow the variometer fastening screws and shaft to pass through, are placed as shown in the photograph. When grounded, these act as shields and prevent bothersome capacity effects.

Follow this order in wiring and use the shortest connections possible. First, connect the variometer stator taps with the inductance switch contacts. In each variometer, the first tap, at the end of 20 turns, is connected with contact 1, the second tap with contact 2, and so on down to the last tap. The taps of V_1 are connected with the contacts of switch *B*, those of V_2 with switch *C*, and those of V_3 with switch *D*.

Next, the filament circuit should be wired. Lead a wire from terminal *G* to one binding post of each rheostat, to one of the outside terminals of *P*, and to one terminal of C_3. Lead another wire from *H* to one of the *F* terminals of each tube socket and to the other outside terminal of *P*. Now connect the middle terminal of the potentiometer *P* with *J* and with the remaining terminal of C_3.

From each of the remaining terminals of the rheostats run connecting wires to the remaining *F* terminals of their respective tube sockets.

(*Continued on page 127*)

The Proper Finish Will Make Your Furniture Harmonize

The furniture, woodwork and floors of your home can be made to harmonize if a little taste is used in finishing them. You can easily refinish dingy, shabby, scratched wood. Our method involves practically no expense. All you need is a little time—a brush—and **JOHNSON'S WOOD DYE.**

Small odd pieces of modern furniture add greatly to the attractiveness of every home. You, yourself, can easily make them for your family. There is no particular trick to constructing porch swings, tables, telephone sets, etc.

Johnson's Wood Dye is very easy to apply—it goes on easily and quickly, without a lap or a streak. It penetrates deeply, bringing out the beauty of the grain without raising it—dries in four hours and does not rub off or smudge.

JOHNSON'S WOOD DYE

If you are building or remodeling you should have our book on Wood Finishing. It is chock full of valuable information. Tells just what materials to use and how to apply them. We will gladly send it free and postpaid. Use coupon at right.

JOHNSON'S WOOD DYE has many uses, for both the artisan and amateur. *Architects and contractors specify it* for coloring woodwork and flooring in new buildings. *Painters and decorators* use it with equal satisfaction on new and old woodwork of all kinds. *Housewives* delight in it for doing over old furniture and for coloring reed and wicker baskets, etc.

JOHNSON'S WOOD DYE is made in fourteen standard shades—a few of which are:

129 Dark Mahogany	*126 Light Oak*
127 Brown Mahogany	*123 Dark Oak*
140 Early English	*110 Bog Oak*
131 Walnut	*124 Golden Oak*
125 Mission Oak	

All shades may be easily lightened, darkened or intermixed. Full directions on every label.

FREE-This Book on Home Beautifying

This Book tells how to finish wood in artistic stained and enameled effects. Gives practical suggestions on making your home artistic, cheery and inviting. Tells just what materials to use and how to apply them. Includes color card—gives covering capacities, etc. Use coupon below.

S. C. JOHNSON & SON, PS11
RACINE, WIS. (Canadian Factory—Brantford)

Please send me free and postpaid your Instruction Book on Home Beautifying and Wood Finishing.

The best dealer in paints here is .....

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MY NAME..... .....

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Better Shop Methods

How Expert Mechanics Save Time and Labor

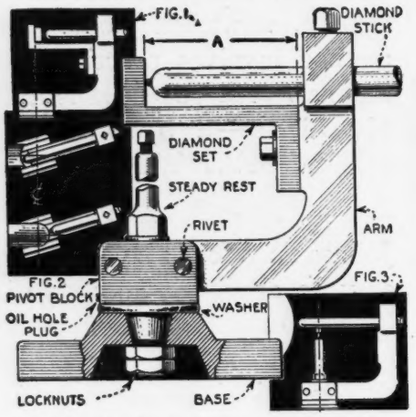
To Dress Curved Grinding Wheels Truly

By Henry S. Laraby
Toolmaker and Tool Designer

WHENEVER concave or convex surfaces are to be ground, it is a tedious, inaccurate and wasteful process to shape the wheel by hand with a stick diamond. The workman sometimes uses up nearly the entire wheel before the proper curvature has been obtained, and even then the grinding surface often is badly grooved because the diamond has been held by hand.

To overcome these difficulties and place the dressing of curved grinding wheels on an efficient basis, the dressing attachment illustrated was designed, and it has proved its value. With the constantly increasing use of grinding in the shop, it saves time and money; it eliminates all guesswork and immediately gives a concave or convex shape that conforms exactly to the shape to which the work is to be finished.

The construction is made clear in the accompanying drawings. A few words may be added, however, as to the use of the fixture. The diamond set fastens to the arm in such a way that when the diamond is flush against it, the point is directly over the center of the pivot block. When the point is located in any other position than this, it swings about the pivot in a perfect arc the radius of which equals the distance from the basic setting.



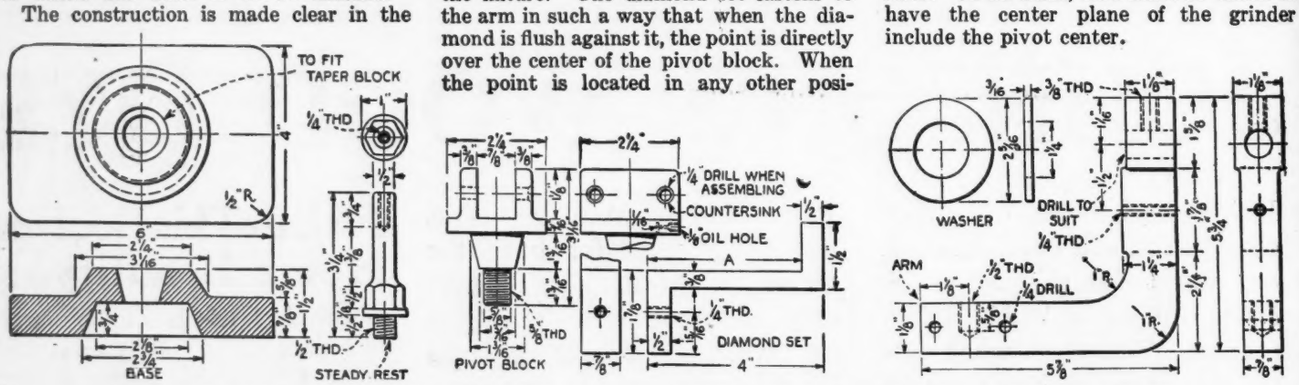
How the dresser is set up and used

For instance, should it be desired to give the rim a convex surface with a radius of 1 in., a block measuring 1 in. is inserted between the diamond point and the set. The stick is then clamped in position, the set is removed, and the grinding wheel is placed so its center is on the axis of the stick. Swinging the arm about the pivot, the diamond is brought against the revolving grinder.

This is continued until the entire circumference of the stone has been dressed.

Any mechanic who has use for this rig can think of a dozen ways to get his measurements after the diamond set is on.

Similar methods are used to set the stick for concave surfaces. The diamond point then projects beyond the pivot and the steady rest is used to support the diamond stick. In all cases, care must be taken to have the center plane of the grinder include the pivot center.



Details of the base, pivot block, arm, washer, diamond set, and diamond steady rest. All the parts are machine steel. The diamond set, which is hardened and ground, is used for setting the diamond accurately, and then is removed from the fixture during the actual process of dressing the wheel

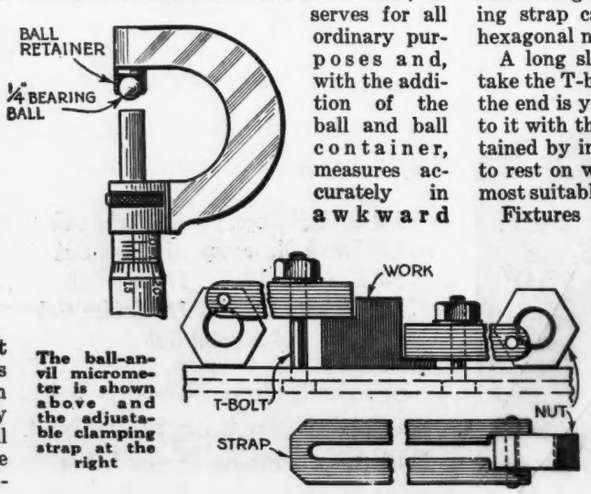
Micrometer Attachment and Variable Height Clamping Strap

By C. M. Wilcox

LOOKING through a recent issue of POPULAR SCIENCE MONTHLY, the writer noted particularly a micrometer attachment used for setting dividers accurately. This suggested another simple and easily made "mike" attachment that allows an ordinary micrometer to be used for gaging the walls of metal cups, tubes, or irregular shaped pieces.

The attachment consists of a short length of light gage brass tubing and a ¼-in. bearing ball. The tube or ball retainer is reamed out so that it will slide over the micrometer anvil. It is crimped as shown, to prevent the ball from dropping out. Bearing balls come pretty close to size, as a rule, but it might be well to gage a number of them and select the most accurate. When using this attachment, the reading is, of course, taken with the .250 graduation as zero.

With this attachment, an ordinary micrometer becomes a two-in-one tool; it serves for all ordinary purposes and, with the addition of the ball and ball container, measures accurately in awkward places where it otherwise would be more or less useless.



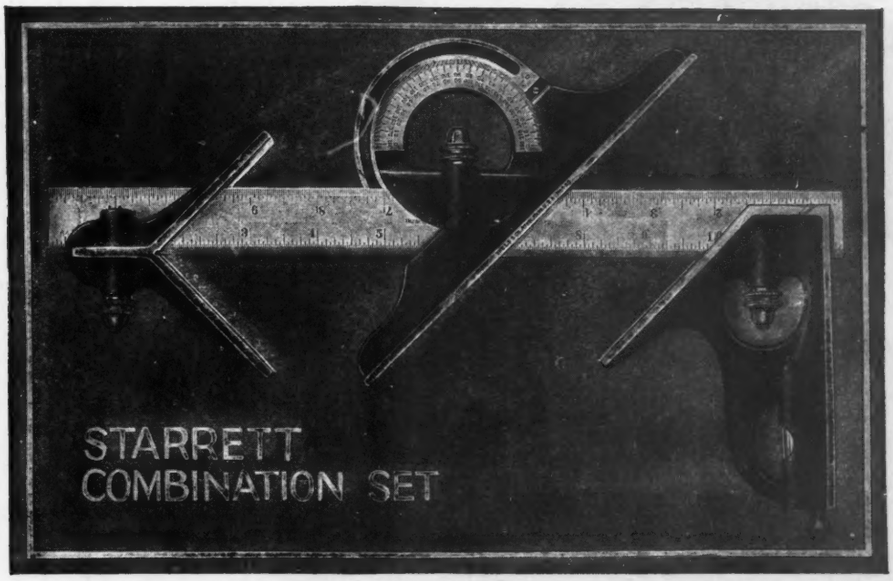
The ball-anvil micrometer is shown above and the adjustable clamping strap at the right

Another machine shop kink worth remembering is that a variable height clamping strap can be made of three parts—a hexagonal nut, a strap, and a hinge pin.

A long slot is provided in the strap to take the T-bolts used in the work table, and the end is yoked over the nut and fastened to it with the pin. Varying heights are obtained by indexing the nut and allowing it to rest on whichever one of its sides is the most suitable.

Fixtures made in this way avoid the necessity for hunting around for odds and ends of blocking to be used with the ordinary "jack" straps.

How to build a cheap but very efficient water still for use in auto and battery repair shops will be told next month. There will be helpful machine shop kinks by Joe V. Romig, Henry S. Laraby, C. M. Wilcox, and other experts.



"The most useful tool ever built"

YOU ought to own one of these famous Starrett Combination Sets. With its Drop-Forged Steel Combination Square, Reversible Protractor Head and the Center Head, here's a practical, handy tool that for general all-round work has yet to be equalled.

The Combination Square (with Spirit Level and Scriber in the Head) alone gives you seven tools in one—Rule, Square, Miter, Depth Gage, Height Gage, Marking Gage, Level and Plumb. Add the Protractor and Center Head, and you've got a set of accurate tools that you'll use constantly in a hundred and one different operations.

And useful as it is, the Starrett Combination Set (No. 434 is illustrated) takes up but little room in your kit and saves littering the bench with the separate tools needed to do the same work.

Heads slide easily along the Blade and can be instantly removed or clamped at any desired position. All parts nicely finished, of the best workmanship and reliably accurate. For doing close work easier, you'll find the purchase of one of these Starrett Sets the best investment you ever made.

For complete description of the different Starrett Sets and Attachments, write for the Starrett Catalog No. 22"W"

THE L. S. STARRETT CO.

The World's Greatest Toolmakers
Manufacturers of Hacksaws Unexcelled
ATHOL, MASS.

a few uses—

Machinists

Laying out
Bench work
Leveling shafting, etc.
Setting up machine tools

Auto-Mechanics

Lining up shafts, bearings, connecting rods, crank shafts, etc.
Truing cylinders
Checking up valve seats
Timing valves

Carpenters

Laying out mortises, tenons, dentils, stringers, etc.
Cutting rafters and jacks
Scaling blue prints
Leveling and plumbing jambs, casings, etc.
Marking gage, rabbet gage, butt gage, etc.

5757 **Starrett Tools**

most accurate. When using this attach-

Where
ONLY A FILE
will do---

Mr. Handy Man, to keep the home shipshape, *must* have the proper assortment of files.

For instance: To smooth the edges on a warped door or to clean metallic surfaces before soldering---use a Half Round Bastard File. To fit stove linings --- use a Cabinet File.

To sharpen knives and shears---use a 6" X-F Swiss Pattern File No. 2.

To sharpen a hatchet, axe or pair of skates---use a Mill Bastard File.

A Warding File will make a rusty key fit.

A Half-Round File will teach a window catch to behave. A Slim Taper File will sharpen a saw.

You need a Mill File for sharpening the lawn mower or garden tools. And by all means a Tungsten Point File for your motor repair kit.

You'll find every one of these Files in the NICHOLSON brand. Several in the NICHOLSON brand exclusively.

Sharpness, cutting-accuracy and edgeholding qualities are certainties wherever you see the NICHOLSON trade mark on the tang of a File.

Tell any conscientious dealer your purpose, and he'll select for you the NICHOLSON Files you need.

NICHOLSON FILE Co
Providence, R. I., U. S. A.

NICHOLSON FILES
-a File for Every Purpose

Old Bill Wins a Race in Assembling Pumps

By Joe V. Romig

DO YOU plan your work in detail, or do you rush headlong into a task, starting at the first angle that happens to strike your fancy? If you are still a young man, you probably follow the latter method, just as I did before Old Bill set me right.

It was while I was a machine hand that Old Bill, the layer-out, taught me the lesson that enabled me to grow, and I am presenting it in the hope that another may be lifted out of the rut by a bit of his wisdom.

Old Bill and I had been given the job of setting up two sand pumps, each consisting of a base in three parts, the two pump castings and their rotors and shafting, together

"Rather make your work right the first time than feel proud of your ability to repair a bull"

with stuffing boxes and bearings and a centrally mounted motor with couplings for driving the two centrifugal pumps.

As we started, Old Bill nudged me in the ribs with his crippled hand and said, "Joe, I'll get mine done before you do."

I took up his challenge and we started off, he going to the stockroom and I to locate my base sections. By evening I had the three pieces drilled, doweled, and bolted together, lying perfectly level on two floor parallels, while all Bill had to show for his day's work was a heap of castings and several boxes of bolts and nuts.

During that first day, as he passed me he would say, "Joe, you're working hard. Why, I haven't started yet!"

In spite of all my hustling, he was ready to pour his bearings as soon as I. Thereupon he offered to help me pour mine first, but I rejected his kind offer, being proud and foolish. Bill left to chin with an old crony until I should finish.

Upon his return he took one look at my work and then remarked, "You think you are still ahead, Joe, but really you are not. Your bearings are one sixteenth of an inch too low. Mine have yet to be done, but yours have to be done over."

Quickly I took up my foot rule and measured. Sure enough, Bill was right. I had not taken into consideration the shrinkage of the metal. Thereupon I doubled my pace, rushing to the stockroom for materials as I needed them, and often going two or three times for the same articles because I had not consulted the bill of materials.

All my haste was of no avail. Old Bill had his pump inspected and passed an hour before I tightened up my last bolt and nut.

After we had cleared away our tools and equipment, he called me over to his layout table and while fumbling over the blueprints

(*Continued on page 86*)

The "B" Battery is the Life of Your Radio Set

THIS IS NUMBER ONE OF A SERIES

THE only function of your Radio set is to produce sound-waves—those mechanical disturbances in the air caused by some rapidly vibrating body. So far as the Radio set itself is concerned the actual source of the sound is the "B" Battery. It is not an exaggeration to say that the "B" battery is the "life of your Radio"; for the set itself is simply a device to reproduce sounds, and the sounds all have their origin in the "B" Battery.

The "B" Battery is simply a box full of electrical energy; harnessed for you by experts. Without the Radio wave the flow of energy from the "B" battery is smooth, steady and *silent*. It is the final aim and purpose of all the many parts which go to make up a Radio receiving set, to convert the otherwise steady flow of electrical energy from the "B" Battery, into a rippling, vibrating, throbbing, audible current.

As the sound-waves—whether caused by the human voice in talking or singing, or by musical instruments—are modulated up and down—now high—now low; so does the current from the strongly vital "B" Battery follow the modulations and the variations, so that the original message, in all its delicacy of tone and vibration, comes clear and distinct through your Radio set.

Not a mere adjunct to the pleasure-giving quality of your Radio set is the "B" Battery—instead, it is the vital, life-giving part—the very heart of your Radio set.

Do not slight this vital part—give your Radio set the advantage of the best—use Eveready "B" Batteries.

Note: This is No. 1 of a series of informative advertisements which will appear in this magazine. They are designed to help Radio users get the most out of their Batteries and Radio sets. If you have any battery problem, write to G. C. Furness, Manager Radio Division, National Carbon Co., Inc., Long Island City, N. Y.

The *New* Metal Case Eveready "B" Battery

(No. 766)

"The Life of Your Radio"

The same popular 22½ volt Eveready "B" Battery in a *new*, handsome, durable, waterproof, metal container. Eveready quality throughout. At all dealers, $3.00.

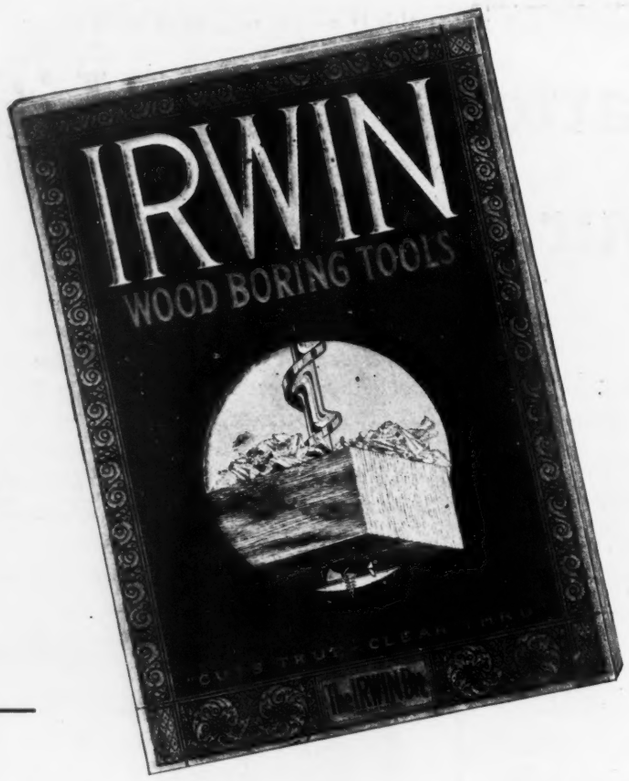
The "B" Battery is the vital part of any radio receiving set. Eveready Batteries—especially made for Radio—serve better, last longer and give better results.

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, Inc.
Long Island City, N. Y.

EVEREADY
Radio Batteries
—they last longer

If You Use Bits—



Send for this Book —it's FREE!

WHEN you bore holes you want the bit best adapted to the job,—the one that will bore the greatest number of holes with the least effort and least wear on the bit. No *one* bit is suited to *all* kinds of boring. Various kinds of wood, plus different boring requirements, obviously make necessary a corresponding difference in bits and augers to best meet those needs.

That's what this book tells about.

It Gives the Answer to Many Bit Problems

It is filled with important facts about bits and their uses and tells how you can accurately select the right bit for any job of boring.

It Tells—

—the essentials of wood boring.
—the various parts of a bit.
—about the cutting head of a bit.
—what makes the speed of a bit.
—the boring requirements of various kinds of wood.
—the comparative power required for boring different kinds of wood.
—how IRWIN Bits and Augers are made to meet those requirements.
—the reason for the uniform quality of IRWIN Bits and Augers.
—how IRWIN Bits and Augers are heat treated.
—about the IRWIN Bor Family.
—why different lengths and sizes of bits and various cutting heads are necessary to complete the IRWIN Bor Family
—how the Bor Family is easily identified by the name of each member stamped on the shank of the bit.
—the length, size, and list price of all IRWIN Bits and Augers.
—how IRWIN Bits are put up in Sets for the greater convenience of bit users.
—how each IRWIN Borset is named to indicate the purpose for which it is best adapted.
—how IRWIN Borsets are packed in three styles of containers—the Borcase, the Borkit, and the Borchest.
—about the care of bits—how they should be resharpened, etc.
—about the IRWIN Trade Mark and what it means.
—about the IRWIN Guarantee Tag and what it means.

In short, this new IRWIN Booklet is practically a dictionary of wood boring tools and their uses, and should be in the hands of every man who uses bits. Get your copy NOW—it's FREE. Send TODAY, giving name and address of your hardware dealer.

TO HARDWARE DEALERS:—If you haven't received your copy of this new booklet, ask your Jobber, or write us, giving your Jobber's name.

Address Dept. 111

The Irwin Auger Bit Co., Wilmington, Ohio

CUTS TRUE The IRWIN Bit Reg. U.S. Pat. Office *CLEAR THRU*

Old Bill Wins a Race

(*Continued from page 84*)

he delivered to me the most helpful lecture I have ever had the good fortune to hear.

His theme was, "Plan Your Work." He said it was his ability to plan that made it possible for him to compete with the younger and more active machinists. Instead of rushing blindly about trying to establish a time record, one should go about the work systematically. First, study the blueprints; know every piece and its location on the finished job; then study the material list, and you will have a mental picture of the entire task.

"Why, Joe," he said, "I pitied you when you carried all that material down here from the supply room. I did not carry even a washer. I loaded all the parts in a big box and had the crane bring it down. You made a dozen trips; I made only one. I reserved my strength for the work that could not be done with lathes, planers, and cranes, and there is enough of that. When I gave you a chance to babbitt first, you jumped at it, but tell me who cleaned out the forge, who hauled in a barrow of coke, and who hunted up all the ladles around the shop. You worked entirely too hard. If you used my methods and short cuts and added your energy, you would soon be foreman of the shop. Now, listen, Joe, if you are ambitious and really want to succeed, don't work quite so hard and use your head a little more. Make the machinery do the work, as I do."

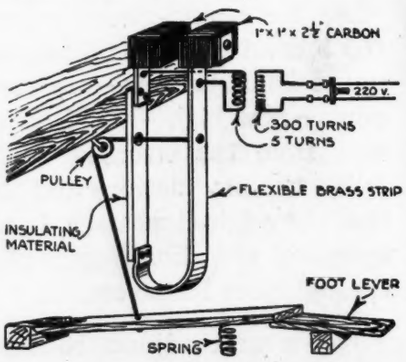
As we put our tools away and washed up, he gave me a last bit of advice, which was, "rather do a job right the first time than feel proud of your ability to repair a bull."

I had learned from Old Bill, in one short day, more than I should have learned in a year if left to myself.

Electric Machine for Soldering

IN AN electrical shop or any other place where much small soldering has to be done, a simple electrical soldering machine may be made.

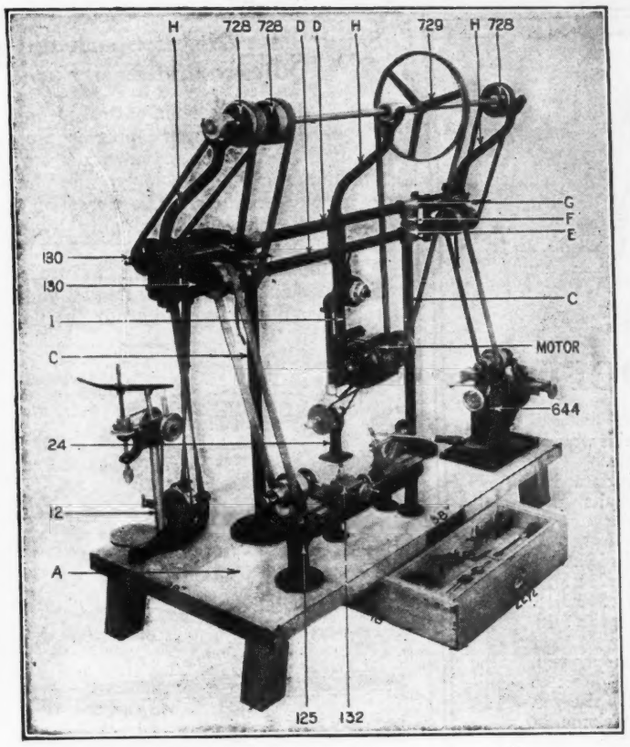
The secondary of an air-cooled dry-type transformer is connected with two carbon electrodes, the backs of which are copper-plated. The transformer is mounted by



Pressing the foot lever unites the electrodes on work for soldering small parts in large quantities

means of iron straps fastened to the core. The primary winding is No. 10 double-cotton-covered wire, and the secondary No. 3 stranded rubber-covered, double-braid cable, wound as shown in the accompanying diagram.

The carbon electrodes are held in contact and therefore heat up whenever the current is on. Pressing the foot lever separates them to permit the work to be inserted.



What the Workshop consists of

(A) *Bench.* Dimensions 58" x 26" x 2". Legs 4" x 4".

(B) *Superstructure.* Two cast-iron flanges 7" in diameter, 1¼" thick, bore 1" bolted to bench with four carriage bolts each 2½" long.

(C) Two pieces of XX heavy 1" iron pipe 28" long threaded at both ends.

(D) Two pieces of 1" iron pipe 58" long.

(E) Two 1" crosses.

(F) Two 1" close nipples, double heavy.

(G) Two 1" T's, heavy duty type.

(H) Three offsets supporting jack shaft, forged out by a blacksmith and offset forward approximately 12" and upward 10".

Motor. One-quarter horsepower 1,700-1,800 revolutions per minute

(24) G.-P. Polishing Head No. 24.

(12) G.-P. Bench Drill, No. 12.

(125) G.-P. Bench Lathe, No. 125.

(132) No. 132 Slide Rest.

(644) Milling Machine No. 644.

(130) G.-P. Countershafts No. 130.

(728) G.-P. Aluminum Pulley No. 728.

(729) G.-P. Aluminum Pulley No. 729.

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Starting with the bench, superstructure, and a one-quarter horse-power motor, you can build up this Home Workshop with the Goodell-Pratt Tools listed at the left.

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Toolsmiths

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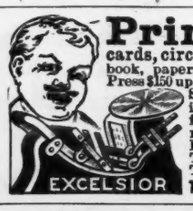

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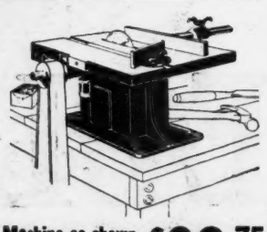
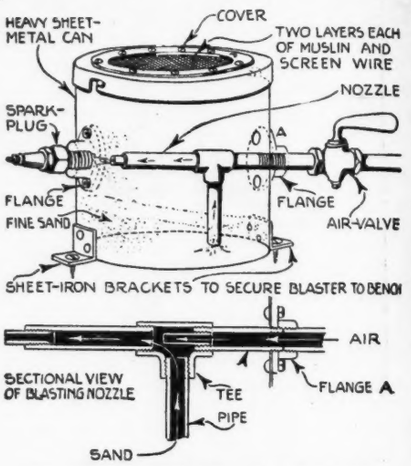


Machine as shown with guides and saw, ... $28.75

Sand Blast Cleans Spark Plugs Quickly and Easily

TO CLEAN the carbon entirely from the porcelain of a spark plug is difficult even if the porcelain is removed from the shell, and in non-separable types of plugs it is even more tedious. The porcelain can, however, be cleaned thoroughly by sand blasting in a few seconds.

The illustration shows a fixture into which a spark plug can be screwed and the garage air supply used to scour the porcelain with sand. The casing can be made from any heavy sheet metal can or box. Two flanges are riveted into the sides exactly opposite each other. One serves as a fitting into which a spark plug can be screwed; the other as an air connection.



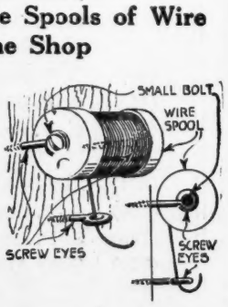
Phantom view, showing the cleaner in operation and section of the nozzle

Make a blasting nozzle of short sections of pipe and connections, as shown. The lower end of this T should be about 1/2 in. above the bottom of the casing. Cut out the top of the can or casing and rivet in place two layers of muslin between two layers of screen wire.

Place ordinary building sand to a depth of 3/4 in. in the bottom of the can, screw in the plug, and turn on the air. Renewal of the sand is occasionally necessary.

How to Handle Spools of Wire in the Shop

SPOOLS of iron, brass and copper wire, such as are commonly used in the shop, can be mounted conveniently by the use of holders made with three screweyes and a bolt. Two of the screweyes serve as brackets and through them passes the bolt, which forms a spindle for the spool. The third screweye acts as a guide for the wire.

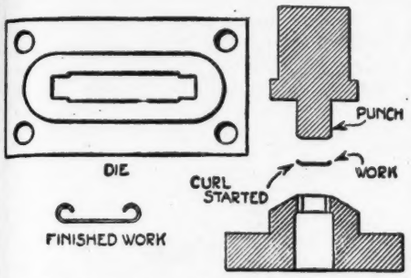


The use of the holder prevents the loss of wire caused by spools unrolling when thrown together in a box or drawer. Each spool being set on a holder of its own makes it easier to find the size and kind of wire desired without delay.

A FIRST-RATE metal polish can be made from clam or oyster shells. The shells are burned over a coal fire for half an hour and pounded to a fine powder.

This Curl-Starting Blanking-Die Saves One Operation

THE curl-edged tin handles for cups are usually blanked out flat in the first operation, the curl started in another die in the second, and the curl finished in the



By beveling the punch, a curl is started at the first blanking operation

third. By beveling off the cutting face of the punch, however, the blank will have the curl started.

This does not affect the smooth cutting of the punch, and at the same time saves an operation.—S. A. McDonald.

Extending Small Drills

TO EXTEND small drills with a minimum of work, the method shown in the accompanying drawing may be used advantageously. Grind the shank of the drill to a triangular section and grind the end squarely across to make the corners so sharp that they will serve as a sort of

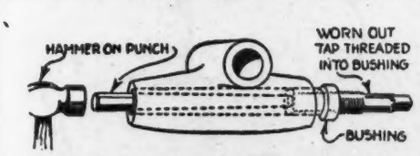
The triangular shank of the drill broaches itself into the extension

broach. Then drill the extension, which usually will have a taper shank, about ⅜ in. deep with a hole to make a snug fit for the drill. Extend the hole about ⅜ in. deeper with a drill 1/32 in. smaller.

The drill is then driven into the extension so that the three-cornered portion broaches three grooves, as shown. When the drill is worn out or breaks, it may be replaced quickly.—H. P.

Extracting Worn Bushings

ALMOST every mechanic has experienced difficulty in extracting worn bushings from machinery of one type or another. The next time you are confronted with such a problem, obtain some old worn-out machine or pipe taps. Choose one of a



A discarded tap is used to plug the bushing

size to jam a thread into the bushing; in other words, a tap larger than the hole in the bushing, so that the tap will thread itself in. Then with a punch and hammer drive out the bushing.

The more worn the bushing the better this plan will work because the tap will crowd deeper into the metal.—J. R. S.

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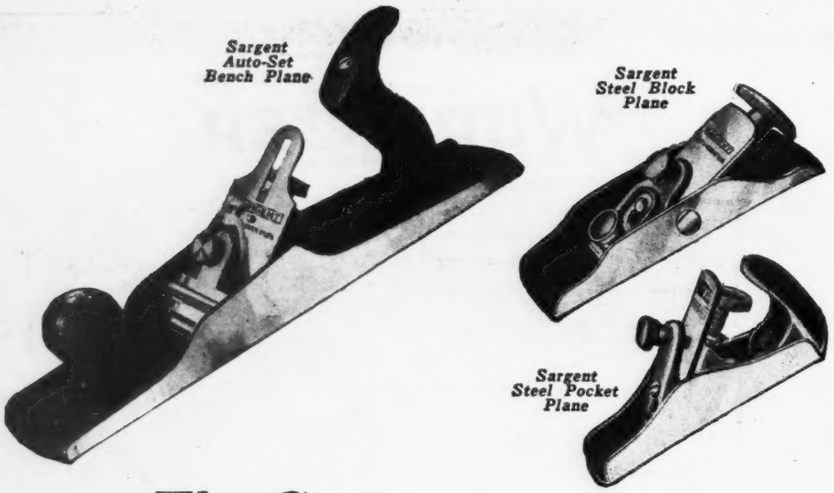

The Cutter of Chromium Steel HOLDS ITS EDGE

ALMOST as sharp as a razor blade; even after considerable cutting! Zing!—with the grain, 'gainst the grain and 'cross the grain—feel the Sargent Auto-Set Bench Plane cut, smoothly and cleanly.

The diamond-like toughness of chromium alloy permits the use of a thin blade—and the thinner the blade, the keener the cutting edge. The advantage of a thin blade is also emphasized when it finally needs whetting. It is honed in a jiffy—replaced—and shaving away in short order, with the original adjustment unchanged.

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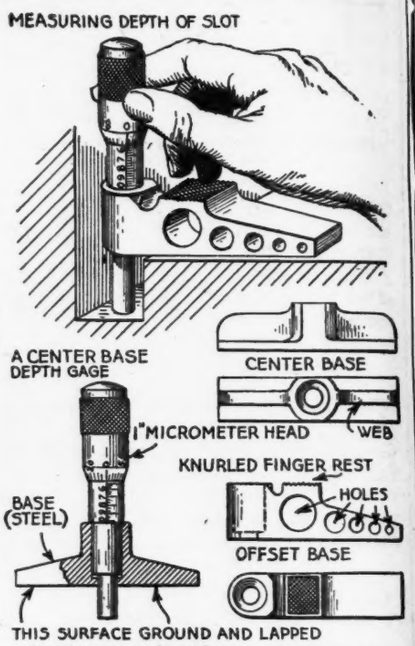
Micrometer Head Used in Making Accurate Depth Gage

BY USING a micrometer head, which can be obtained for a few dollars at any large hardware store, the machinist can make a handy and very rugged depth gage.

The base can be of either shape shown or modified in any way the maker desires. It should be made of good tool steel and as much of the finishing as possible should be done on a surface grinder. The lower surface is then lapped true on a lapping plate



Combined with either a center or an offset base, a micrometer head serves as a useful depth gage

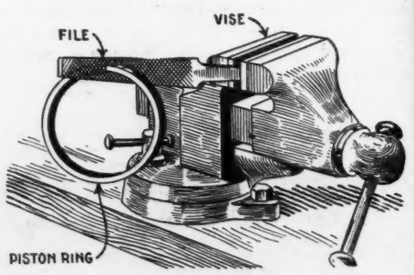
with fine emery powder mixed thinly with lubricating oil. Care should be taken to obtain an accurate, mirror-like surface.

The hole for the micrometer head is then bored by mounting the base piece on the faceplate of a small lathe and drilling and boring the hole for a light press fit over the end of the micrometer head.

The advantage of the offset head shown is in making measurements in corners where there is little room.—M. C. I.

Fitting Piston Rings Quickly

PISTON rings may be fitted more quickly than by the usual method of clamping the rings in the vise, by using a file



To save time in fitting, the file, instead of the ring, is clamped in the vise

clamped in the vise. Hold the ring with both hands and draw it along the file.

Since the ring has to be tried frequently in the top of the cylinder, this method avoids unnecessary handling of the vise and file.—L. A.

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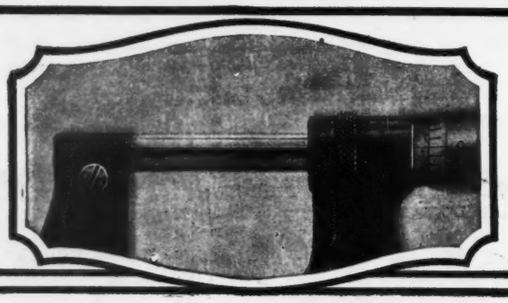

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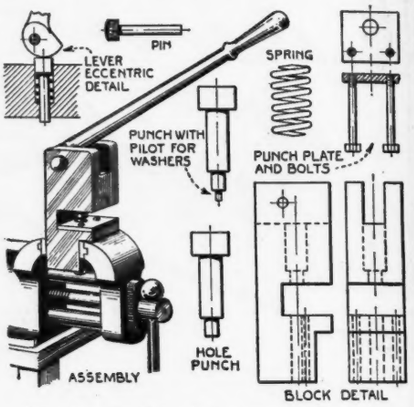
Hand Punch for Small Work Is Held in Vise

TIME and labor can often be saved in the shop if a small hand punch for the bench vise is available to handle work that cannot be done economically on a power punch.

The base of this small punch is clamped in the jaws of the vise and the lever pulled down by hand. Punches and corresponding punch plates are made to suit the work and can be changed readily. Two screws engaging tapped holes keep the punch plates



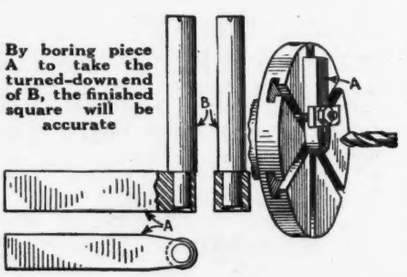
The vise punch ready for use and its parts

in place, and by removing the lever pin one punch can be substituted for another. When punches of large diameter are used for making up small washers, a removable pilot is screwed into the center of the punch, as indicated. Pilots of various sizes can be used with any one punch.

The base block and lever are forged steel and the cam end is hardened to resist wear. The lever is held by a removable pin, and a single heavy spring retracts the punch. All the punch bodies are the same diameter for interchangeability.—L. A.

Making an Accurate Square

HOW to make a small square of tested accuracy with limited equipment in the shortest possible time is a puzzle to many new mechanics and perhaps some journeymen. It can be done, however, quite easily by using a piece of cold rolled



steel, of rectangular section, as at *A*, and a turned round piece, *B*.

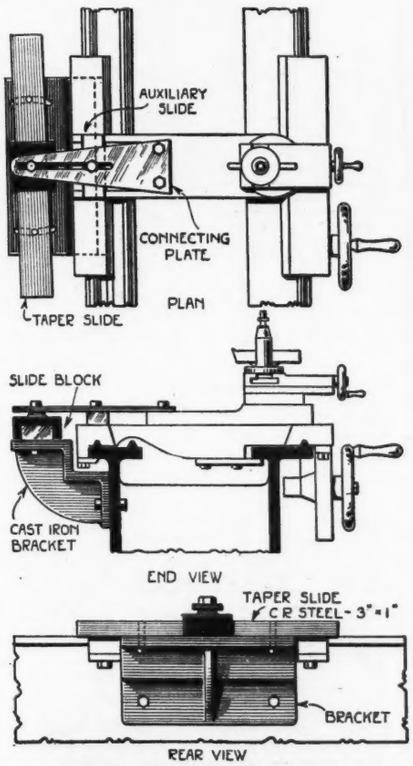
Grind, file, and polish piece *A*, strap it to a lathe faceplate, drill a hole smaller than the turned down end of *B* and, with a small boring tool, bore out a hole for a press fit. This brings the hole dead square with the face of *A*, which is against the faceplate.

Since the piece *B* is generated on centers, it must be exactly accurate, so that when the two pieces are assembled with a light press fit, the square is certain to be exact, provided neither piece is bent or distorted. —W. BURR BENNETT, Scranton, Pa.

Fitting a Taper Attachment on an Engine Lathe

LATHE owners doing taper work, and handicapped through the lack of the necessary attachment, can make at little cost a taper attachment that will answer the purposes of a commercial device.

The attachment consists of an angle plate bracket of cast iron, machined on the top face only, and a piece of flat, cold rolled steel, 1 by 3 in., with a rider slide, steel connecting plate, and an auxiliary slide for stiffening the connecting plate assembly. After being carefully checked for straightness and parallelism, the cold rolled steel piece is mounted on top of the finished surface of the angle plate, as



Three views of the taper attachment, showing how the parts are attached to the bed of an engine lathe

shown. The plate is tapped for cap screws that pass through radial slots in the angle plate. The builder can insert a central pivot pin, but that is not absolutely necessary.

The slide or rider block is cast iron, machined to fit the cold rolled steel bar. A connecting plate is shaped and slotted, as indicated, from a piece of ¼-in. boiler plate. This piece is bolted to the front part of the cross slide proper and, in order to stiffen it, an auxiliary slide is used.

Tapers appear on drawings either as so much taper a foot or in degrees. Work intended for the lathe is usually marked in the amount of taper a foot, and the taper attachment is easily set. Measure off 1 ft. on the machined surface at the rear of the carriage, and, with a scale and microscope, set the taper attachment slide accordingly to one half the total taper required.

For extreme accuracy in your work, an inside micrometer can be used for setting the slide. The turning of curved shapes and forms can be done by using a guide plate with the profile of the form milled in its top surface, and using a roller bolted to the connecting plate, running in the slot.

Ball shapes can also be turned for the center of universal trunnions.—J. R.

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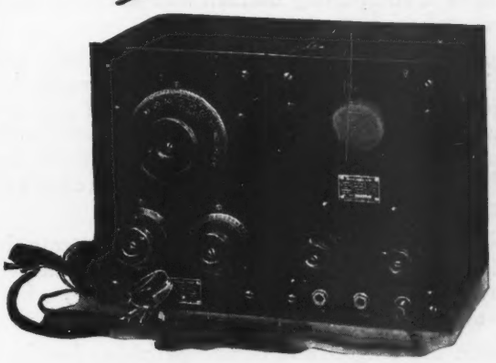

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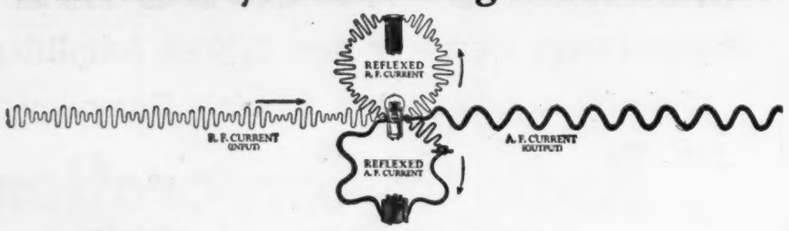
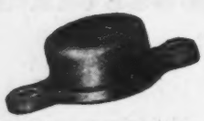


Perfect synchronization of received and reflexed r. f. currents make Erla radio transformers indispensable in reflex work. List, $5

Rectified radio frequency and reflexed audio frequency currents are accurately synchronized by Erla audio transformers. List price, $5



Providing utmost sensitiveness with perfect stability, the Erla fixed crystal rectifier is uniquely adapted for reflex work. List, $1

Dealers and Jobbers—Erla scientific progress steadily opens new avenues of trade and profit. Write for our liberal terms and discounts

For the first time, the full efficiency of vacuum tubes is completely utilized and brought under control.

In Erla reflex circuits, tubes do triple duty, providing simultaneous amplification of radio frequency, reflexed radio frequency and reflexed audio frequency currents. Yet, so precise is the manipulation of this complex current flow, that the tremendous gains resulting are achieved without a single deterrent flaw.

Not only do Erla reflex circuits demonstrate decisive superiority in range and volume, but they are also unequaled in selectivity, purity of reproduction, and ease of control.

Even the single-tube circuit provides far-flung loud speaker range, while the three-tube circuit surpasses costliest multi-stage amplifiers in transcontinental loud speaker reception. And the two-tube circuit is but a step behind.

Essential to the operation of these circuits, and the secret of their success, are Erla synchronizing radio and audio transformers. Providing perfect synchronization of received and reflexed currents having the same phase characteristics, they assure tremendously magnified amplification without trace of instability or distortion.

Complete working diagrams and descriptions of perfected Erla reflex circuits are set forth in Erla Bulletin No. 14, obtainable gratis from leading radio dealers. Or write us direct, giving your dealer's name.

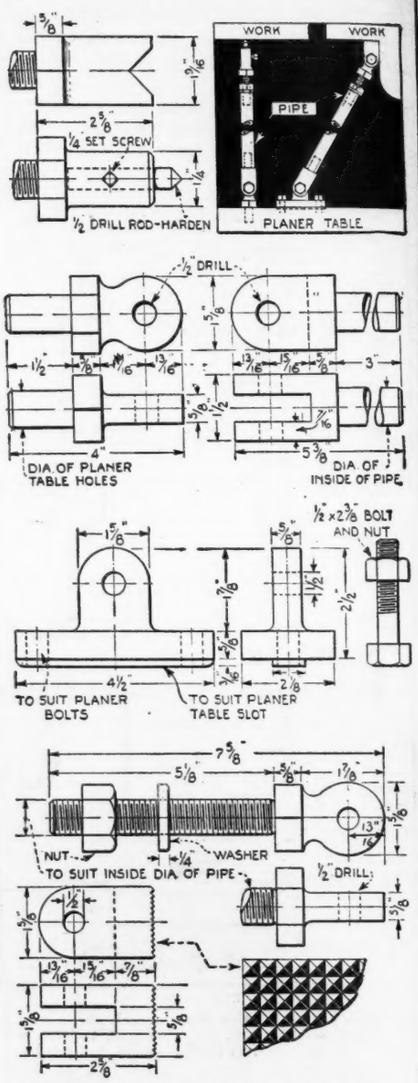
Electrical Research Laboratories
Dept. F 2515 Michigan Ave., Chicago

ERLA

TRADE MARK REGISTERED

How to Make Useful Planer Jacks for Heavy Work

THE planer jack attachments illustrated below solve almost any kind of bracing or pushing problem that arises in heavy machine work. By means of a number of lengths of pipe or round bars bored out at



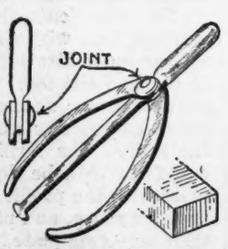
Used with pipe or round bars, these planer jack attachments have a wide range of utility

the ends, the jacks can be made any length to suit the work in hand.

All sorts of jack heads can be provided. One with a sharpened drill rod inserted in it serves for holding flat work, and the usual V-block, for external angles. A hinged block, with a square, diamond-point face, is used when necessary for engaging internal angles.—H. L.

Double Caliper for Forge Work

FOR measuring work that is being shaped at the forge, it is desirable to have a double caliper, as illustrated. It can be set for both width and thickness, and so will measure hot metal with the least waste of time.—G. A.



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See top of page 6 in front of book for full details.

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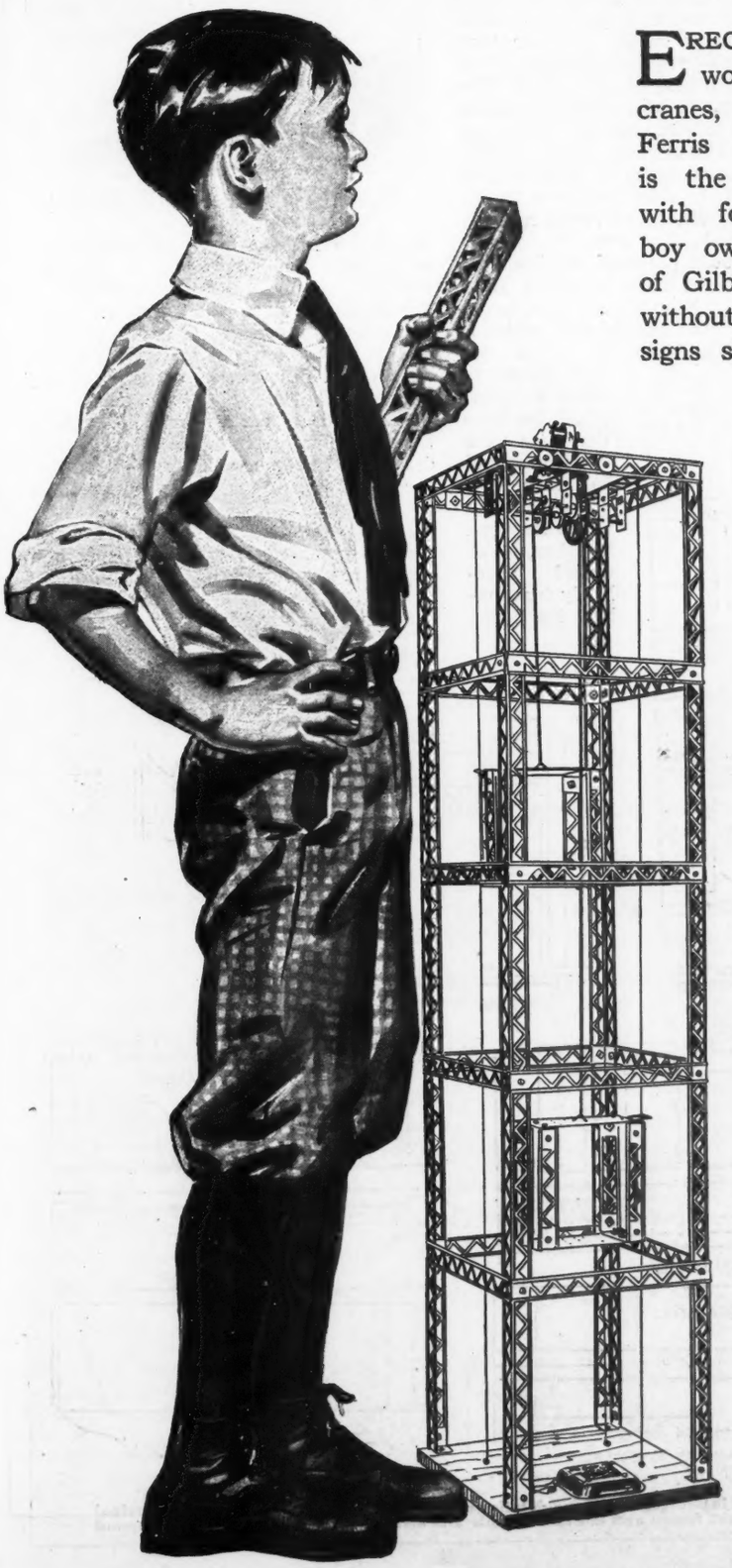
ERECTOR

The famous construction toy



ERECTOR is the best fun in the world. Boys make wonderful bridges, cranes, derricks, windmills, railroad signals, Ferris Wheels and machinery. Erector is the only actual structural steel toy with four sided square columns. Every boy owning Erector is made a member of Gilbert Engineering Institute for Boys without cost. In addition to the many designs shown in the manual accompanying each set, he can win diplomas, honors and awards with original models.

THE A. C. GILBERT CO.
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$5 Gilbert Erector No. 4

THE most popular set. It contains hundreds of parts and is also equipped with a sturdy electric motor to operate cranes, drawbridges and machinery models.

SEND 10 cents to-day for Gilbert Year Book for 1924. Chock full of interesting articles for boys, chemical experiments, athletic sports, tricks, useful articles any boy can make, story of great engineering feats, etc., etc., as well as a complete catalogue of Gilbert Toys.

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Enclosed please find 10 cents for which send me Gilbert Year Book for 1924.

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Makes Dumb Machines Speak for Themselves

TWO QUESTIONS your machine should answer:—

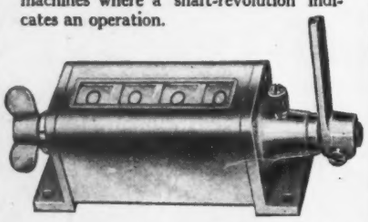
How much does it produce? It will answer you on a Veeder Counter.

How much *can* it produce? That also is indicated on a Veeder Counter.

Compare previous output with what you get after each development-step. That will guide you constantly to better results, *bigger production*—if your machine operates with a

Veeder COUNTER

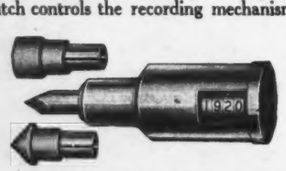
The Revolution Set-Back Counter below records the output of the larger machines where a shaft-revolution indicates an operation.



Sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figure-wheels, as illustrated, $10.00—subject to discount. *Cut less than one-half size.* Set-Back Rotary Ratchet Counter, to record reciprocating movements as on punch presses, $11.50 (list). Smaller counters at prices from $2.00 up.

Speed Counter

Here's the handiest instrument for finding revolutions-per-minute of a shaft or flywheel. You hold the tip of the counter against end of revolving shaft; press lightly when the second hand of your watch comes to O; release pressure when minute is up. A spring clutch controls the recording mechanism.



(Cut less than ½ size.)

The Veeder Speed Counter enables you to keep motors, engines, generators, line shafting and machines operating at *efficient speeds.* Price, with two rubber tips (as illustrated) $3.50.

FREE—The 80 page Veeder booklet shows every counting device an inventor or manufacturer could require. Let us send this free guide.

The Veeder Mfg. Co.,
44 Sargeant St., Hartford, Conn.

The Home Workshop, Continued

How to Build a Mission Library Table

By E. E. Scott

WITHOUT sacrificing any of the simple beauty of the Mission style, the desk-table illustrated combines the utility of both table and flat top desk. Ample drawer space is provided without making the table appear too heavy and cumbersome for the average living room.

Thoroughly seasoned quartered oak, preferably white, should be used throughout, except for the unseen parts and drawers, which can be maple or other hard wood. The table requires 33 board ft. of selected stock, planed on both sides. The stock can be cut to best advantage if five boards from 7 to 9 in. wide and 10 ft. long are obtained. For the legs, which are 2 in. square, it is not necessary to use quartered oak, as two of the sides will show practically a quarter grain if cut from an ordinary 2½-in. oak plank.

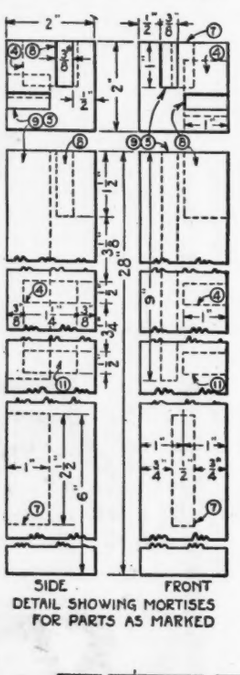
The top should be glued up from the boards having the most beautiful grain and should be built up at first ½ in. larger all around than the finished size, which is 2 ft. 4 in. by 3 ft. 8½ in.

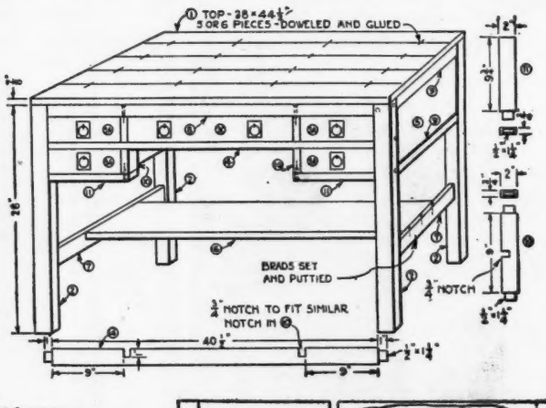
As a piece of living-room furniture, this Mission table has all the utility of a desk

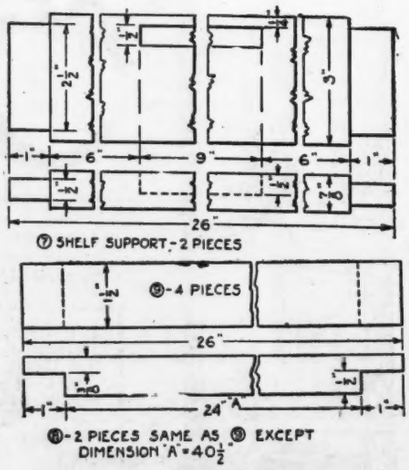
It is worth while to prick punch the location for the dowel holes, and to take the boards to a shop where they can be bored or drilled absolutely true, unless the home worker has a doweling jig or is thoroughly experienced in boring holes perfectly straight. Apply hot, freshly made glue to the edges and clamp the top up on a level surface, using cross boards and handscrews so that the piece will be perfectly flat when finished. The joints should be practically indistinguishable.

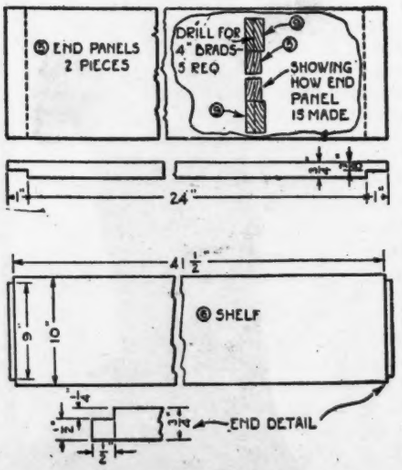
All the other parts should be made to the dimensions given in the accompanying details. The legs should be prepared first because of the number of mortises to be cut in them.

If the planes and chisels are kept sharpened to razor edge, it is surprising how easy it is to work accurately. Bore out as much as possible of the mortises with bits of suitable size. In laying out the legs,







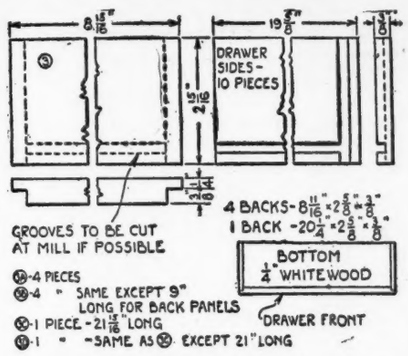


How the table is put together, and details showing exactly how to cut out the principal members of the frame and panels. Details and assembly are numbered to correspond

note that they are made in pairs, two left and two right. As the work progresses, every part should be fitted perfectly, even if the amateur's friend, a file, has to be called into service to insure close fits.

The first parts assembled are the end panels, consisting of two parts No. 9 and one part No. 5, glued and nailed together. Using one part No. 7 and one end panel, attach one pair of legs and repeat this procedure with the other parts of the same number. On the inside surface, which will be out of sight, put several ⅜-in. dowels. Glue all surfaces in contact and dowel wherever possible.

Next, join two pairs of parts Nos. 4, 8, 10, and 11, using screws at the obvious points out of sight, as marked on the sketch of the assembled table. The set of parts that will be at the back should have parts 3B and 3D fitted into them and be glued and held with screws, taking care to set them in ⅛ in. to give the paneled effect. With the aid of the shelf, part No. 6, and the two previously assembled ends, join the whole framework of the table, dowel


DRAWER SIDES - 10 PIECES
GROOVES TO BE CUT AT MILL IF POSSIBLE
4 BACKS - 8 11/16" × 2 5/8" × 3/8"
1 BACK - 20 1/4" × 2 5/8" × 3/8"
BOTTOM 1/4" WHITEWOOD
⑨-4 PIECES
⑧-4 " SAME EXCEPT 9" LONG FOR BACK PANELS
⑦-1 PIECE - 21 13/16" LONG
⑤-1 " - SAME AS ⑦ EXCEPT 21" LONG
DRAWER FRONT

How the stock for the drawers is cut out and put together

and glue it together, bind it with a few turns of rope, and allow it to set overnight.

The drawers should next be made and suitable pieces of maple fitted into the frame on which they will slide. As for the method of placing the drawers, a few minutes' inspection of a buffet or dresser will show just how this is done. For holding the various runs in position, it will be necessary to use eight iron angles. Note that the drawers are to be blocked at the back so that they will stop ⅛ in. in and form depressed panels when closed.

The top is put on by securing four 1½ by 1½ in. maple strips flush with the upper edge directly to the back of parts No. 8 and No. 9, using numerous heavy screws and glue. Turn the table upside down and put screws at 6-in. intervals through the strips and into the table top, but of course not clear through it. Use heavy screws and draw up the top tight by means of a screwdriver bit and brace. All that remains is to plane the top flush with the frame and scrape and sand it.

The finished table can be stained with any good commercial Mission stain, such as fumed oak, weathered oak, green weathered oak, or cathedral oak, coated with thin white shellac and finished with wax or a prepared commercial finish for Mission effects.

If one of the newer two-toned finishes is preferred, it can easily be obtained by brushing out the pores of the wood with a wire brush, applying a coat of stain, followed by a coat of thin white shellac and, when dry, brushing on a coat of silver gray, cream or other light toned, flat oil paint,

(*Turn to page 98*)

PROVED DURABILITY

Nothing seems to hurt a Corona

THE downright toughness of this personal writing machine has always amazed its owners. Can you imagine any typewriter surviving a night's soaking in water?

George W. Warner writes from Salonica, Greece:

"Purchased in 1919, this Corona was banged all over the Balkans—averaging 50 kilometers per day. It spent a night under water in a submerged Ford that ran into a washout, and twice fell from pack saddles into rivers—but it always worked."

Another man dropped his Corona into seven feet of salt water, fished it out, dried it over his camp fire, and wrote 250,000 words before he saw a service station! For 17 years Corona has been meeting and surviving such tests of durability.

Probably you'll never abuse a Corona like this—but there's a lot of satisfaction in owning a typewriter that you know can be relied upon—under all conditions.

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Check and mail the coupon and we will send you some useful personal information about the use of a typewriter in your particular line of work.

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CORONA TYPEWRITER CO., Inc.
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The price of Corona is $50 including a neat carrying case.

"Red Devil" Rapid Boring Bits are 33 1/3% easier boring, have 10% greater clearance, and bore with or against the grain of any wood. Style 2400—10/16 in. shown here, 75c.

A Giant's Grip

"RED Devil" Pliers put power and strength into your hand—a tenacious hold on that stubborn nut or bolt, that screw-eye you want to turn, that wire you want to cut, that rod you want to bend.

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Pliers

—multiply the strength of your hand and wrist—they are your fingers of steel. Made in 100 styles—one for every purpose.

The name "Red Devil" on a plier is a pledge that it is the best of its kind made, that it is forged of tool steel and expertly designed and manufactured.

"Red Devil" Slip Joint Plier No. 1024—6½ in., shown above, is a practical tool for all-around handiness. The slip joint increases its usefulness. Has thin nose for getting into close places. Screw driver in handle. Price, $1.00 a pair at dealers or if not in stock, send dealer's name and order direct.

The "Red Devil" Mechanic's Tool Booklet shows the tools best suited for your needs—send for it—it's free.

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Manufacturers of "Red Devil" Tools
264 Broadway New York, N. Y.

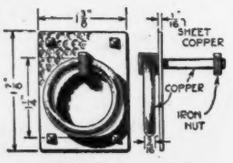
"Red Devil" Glass Cutters—the glaziers' standard tools of the world. "It's all in the wheel." Made in 40 styles. No. 024 shown here, 20c.

Building a Mission Table

(*Continued from page 97*)

thinned with turpentine. When this has set for a few minutes, the surface is rubbed clean with a soft cloth. When the paint is dry, a dull finish varnish is applied.

It is advisable to shellac the drawers inside and out, after they have been fitted. Drawer pulls may be purchased or attractive ones made of copper, as shown. The beaten effect is obtained by laying a flat piece of copper on the bottom of a flat iron, an anvil, or the like, and denting it with the end of a bolt that has been slightly pointed with a file and rounded off.



The hammered drawer pulls

The rings are made by winding 3/16-in. copper wire spirally around a bolt or rod ⅞ in. in diameter and cutting off rings as required. The ends are then squared with a file and soldered together, after they have been passed through holes in copper bolts. These bolts are filed to the shape shown from strips ⅛ in. thick and ⅜ in. wide. It is not necessary to thread the ends of the bolts, for iron nuts will cut their own threads on them.

The square-headed studs that hold the plates in position are filed from ordinary copper tacks. Copper oxidizes quickly to a rich brown that harmonizes with the Mission finish.

Homemade Glass Cutter Replaces Costly Diamond

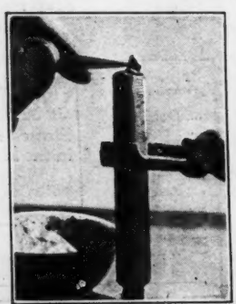
A GLASS cutter that I have found to give better service than the common steel disk type can readily be made at home. All that is required is the wooden handle of an ordinary package carrier, a small amount of lead, tinfoil, solder, or other easily melted metal, and a carborundum crystal.

Carborundum crystals

The wire is removed from the handle and one end blocked up. The metal is melted in a crucible or other dish and poured into the wooden mold, which should be held with a pair of pliers.

Do the pouring with great care, as the metal will bubble quite violently for a moment. When the mold is full, insert a crystal of carborundum quickly while the metal is still liquid, and hold it until the metal sets.

Hold the finished glass cutter firmly and draw the point of the crystal over the glass with a slight pressure, as if it were a diamond glass cutter. It will be found that this quickly made device cuts very much like a diamond.



Mounting a crystal in molten lead

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A 32 page book that's full of practical suggestions on metal-cutting, and general shop information. Every man who buys or uses saws will find it helpful. Send for it NOW. Just write your name and address on the margin of this page and mail it to us.

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I WOULD like to know how to build a model railroad. I enclose ten cents for which please send me your new, smashing 28-page book (thirteen beautiful pages in full colors) showing Ives Locomotives and cars, Ives fleet of Power Boats and Model Yachts. It will tell me all about the different electric and mechanical locomotives; parlor-cars, buffet-cars, mail-cars, freight-cars, oil cars, flat cars, semaphore signals, tunnels, stations, etc.

Please print name and address clearly.

Name.....

Address.....

City.....*State*.....

THE train illustrated below consists of a locomotive, Buffet-Car, Parlor-Car and Observation-Car; and 8 pieces of curved and 4 pieces of straight track, (2 Gauge, 2¼" from center to center) one terminal section, control switch and connecting wire.

This is a wonderful set to start railroading with. Go to your dealer today and ask to see Ives Train No. 701. If he can't supply you, send us $25.00 and we ship direct to you.

"Side-track that freight!
Here comes the express!"

The only vise removable from base for continuous work

The "Yankee" Vise means more speed—greater accuracy. You don't have to remove work from vise until entire job is completed.

When you carry work from bench to drill press, to milling machine, and so on, simply lift vise, work and all, off base.

A "Yankee" Vise always assures perfect alignment; bottom, sides and ends are machined true.

Quickly released from base by turning set screw. Locks in any desired position by cam-throw lever at side. Hardened steel block, with V-shaped grooves, holds round or irregular work.

"Yankee" Vises

with swivel base (detachable)

No. 1994—Body, 10½ in. long; 4 in. wide. Jaws open to 4 in.

No. 1993—Body, 7¼ x 2¾ (wide) x 3 in.; jaws open to 3⅜ in.

No. 1992—Body, 4⅞ x 2 (wide) x 2 1/16 in. Jaws open to 1 15/16.

No. 1991—Body, 3⅝ x 1½ (wide) x 1½ in. Jaws open to 1⅝ in.

Nos. 994, 993, 991. As above, without swivel base.

Some other "Yankee" Tools

Spiral Screw-drivers
Quick-Return Spiral Screw-drivers
Ratchet Screw-drivers
Ratchet Hand Drills
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Illustrates and describes all the ingenious "Yankee" Tools for saving time and labor. Write for copy today.

NORTH BROS. MFG. CO., Philadelphia, U. S. A.

"YANKEE" TOOLS

Make Better Mechanics

Our Blueprints Will Aid You in Building Christmas Presents

WHAT Christmas presents are you going to make this year in your home workshop?

Now is the time to plan. You will find many ideas in this month's Home Workshop; many more will be published next month; and there is the long list of POPULAR SCIENCE MONTHLY blueprints to draw

Thumbnail sketches of Home Workshop blueprints, except No. 8 and No. 28, the latter being illustrated on page 79

upon. This list is particularly valuable, for it contains designs of unusual attractive-

(*Continued on page 101*)

Complete List of Blueprints

ANY one of the blueprints listed below can be obtained from POPULAR SCIENCE MONTHLY for 25 cents. The Editor will be glad to provide, upon request, information relative to tools, material, or equipment.

Blueprint Service Dept.
Popular Science Monthly
225 West 39th St., New York

GENTLEMEN:

Send me the blueprint, or blueprints, I have checked below, for which I inclose.....cents in stamps or coin:

No.	Title	Price	
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2.	Smoking Cabinet	25c	☐
3.	Book Trough End Table	25c	☐
5.	Kitchen Cabinet	25c	☐
6.	V. T. Radio Receiving Set	25c	☐
8.	Shaving Cabinet	25c	☐
9.	Arbor with Gate and Seats	25c	☐
10.	Porch Swing	25c	☐
11.	Bench and Tilt-Top Table	25c	☐
12.	Electric Washing Machine	25c	☐
13.	Tea Wagon	25c	☐
14.	Toy Train, Horse, and House	25c	☐
15.	Home Workshop Bench	25c	☐
16.	Inlaid Radio Cabinet	25c	☐
17.	Cedar and Mahogany Chest	25c	☐
18.	Telephone Table and Stool	25c	☐
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20.	Flat Top Desk	25c	☐
21.	Colonial Writing Desk	25c	☐
22.	Girl's Cabinet and Desk	25c	☐
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IF your work calls for the use of expansive bits and other bits with large size shanks, here is just the brace you need—No. 1052 Millers Falls Brace.

The chuck is strong as Hercules and heavily knurled, to afford a good firm grip. The jaws are of the interlocking type, self centering, forged from steel and spring tempered.

Every carpenter and mechanic should have this brace in his kit. He will have plenty of chances to use it—and he will always use it with real satisfaction.

Ask your dealer to show you this new Millers Falls tool—No. 1052 Brace.

Specifications:

Cocobola head and handles.
Exposed metal parts polished and nickel plated.
Chuck with interlocking jaws, for large size bit shanks.
Ratchet—boxed.
Head—ball bearing—full steel clad.
Handle—Inserted metal rings.
Sweep—10 inches.

Millers Falls Brace No. 1052

Interlocking Jaws—steel forged and spring tempered.

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Millers Falls, Mass.

Manufacturers of Carpenters' Tools, Hack Saws and Automobile Tools

MILLERS FALLS TOOLS
SINCE 1868

Blueprints for Christmas Gifts

(*Continued from page 100*)

ness and utility for Christmas gifts.

The sewing table, Blueprint No. 1, of which hundreds have been made, forms an always welcome gift for a woman. More elaborate and even more popular is the remarkably fine kitchen cabinet, No. 5. The tea wagon, No. 13, the cedar and mahogany chest, No. 17, the telephone table and stool, No. 18, the grandfather's clock, No. 19, the Colonial writing desk, No. 21, the gateleg table, No. 24, and the kitchen cabinet work table, No. 27, are all articles of furniture that make excellent gifts.

For the smoker, there is the smoking cabinet design, Blueprint No. 2, which is the equal of some of the most expensive commercial cabinets featured by exclusive Fifth Avenue, New York, tobacconists.

Blueprint No. 14 gives details of a toy train, kiddie horse, and doll's house, which make fine gifts for children.

A study of the list on the opposite page will show the wide variety of valuable gifts that can be made at home.

Each blueprint is a sheet 15 by 22 in., with complete working details, some of them full size, and an itemized list of materials.

Prizes for Photographs

IF YOU have made or are making any article with the aid of POPULAR SCIENCE MONTHLY'S blueprints, don't fail to take a photograph of your handiwork. Then send us a print. We are always glad to see such photographs, and for each one considered worthy of publication we shall pay $2. Address the Home Workshop Editor, Popular Science Monthly, 225 West 39th Street, New York.

Polishing Turned Metal Work in a Small Lathe

WHEN a fine polish is required on a piece of plain turned metal, excellent results can be obtained by the method illustrated. A piece of flat spring is clamped to the toolholder of the slide rest in such a way that it exerts a light pressure on the work. The end of the spring is bent to conform roughly with the arc of the work and the extreme tip bent sharply down.

A spring holds the polishing pad in place

Between the end of the spring and the work is placed a pad of thick felt or a built-up pad of several thicknesses of soft cloth. The pad is charged with polishing material and is moved along the work by means of the slide rest.

The polishing material used at first will depend upon the quality of the tooling; that is, if the last cut was smooth and clean, a very fine polishing material can be used at once. For the final finish a little jeweler's rouge is excellent. The pad should be changed each time a finer polishing material is used to avoid scratching.

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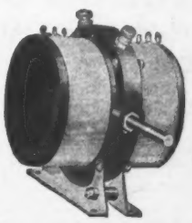

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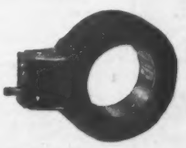

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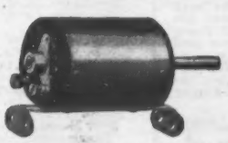

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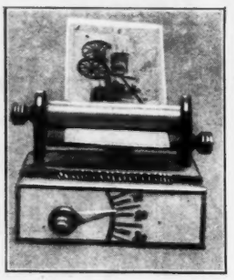
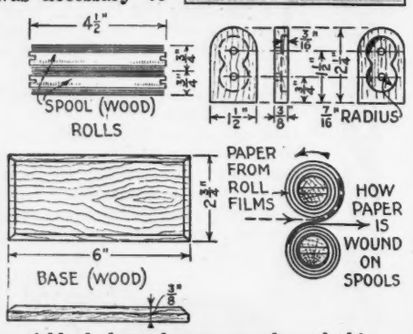
Magic Printing Press Constructed with Old Photographic Film Rolls

THIS easily made magic printing press has offered much amusement to its owner and his friends. It differs from ordinary designs for the same toy because of its very smooth and mystifying action and its colorful accessories. Four Graflex film rolls, 4¼ by 3¾ in. in size, were wound on two spools in the direction indicated in the drawing. Since the paper is black on one side and red on the other, it was necessary to paint the red out with a dull finish black drawing ink. Any strip of tough paper can, of course, be used instead.





A blank sheet of paper run through this "printing press" emerges with a picture

The spools are simply round rods, and the knobs ordinary drawer pulls. The brackets and base were made as shown and the whole apparatus assembled and mounted on a box, to which was added a length of coiled wire and a knob, pointer, and scale. The latter are simply dummies to add further mystery to the operation of the press.

In operation, a blank piece of paper is slipped between the rollers from the front and the knobs are turned. The paper apparently comes out on the other side printed, although, in reality, it has been rolled up unseen on the top roller, and another printed piece of similar width and texture has emerged from between the paper layers of the lower roller.

Writing Ink Etches Permanent Mark on Steel Tools

SIGN your name or draw any mark on a polished steel surface with a fountain pen or an ordinary pen and writing or drawing ink, and the mark will be visible for many years, regardless of how much the surface of the steel is wiped. It does not give a conspicuous marking, but is sufficient to identify the tocl.

Written initials will remain visible for years

A pair of shears with the date 1907 still bears the ink marks as plainly as ever. Marking over the same place several times will serve to make the impression more discernible.

This method of marking is also easy for tools and knives.—F. R. T.

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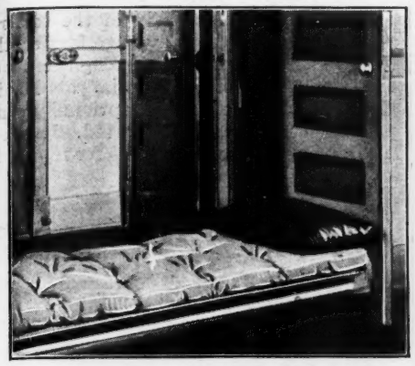
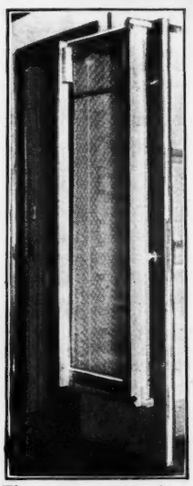
Couch for Emergency Use Hidden Behind Cupboard Door





The cot ready for use (above) and fastened behind the door (below)

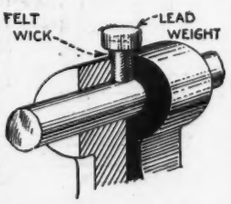
WHERE space for an extra bed or couch is lacking, as in a small house or office, an emergency cot can be hinged to the back of a closet door. It was to provide a couch in an office that the wardrobe bed illustrated was designed and built.

The bed frame was made a trifle smaller than the door of the closet. Hinges attached to the lower end permit the bed to be raised against the door and held in position by a rope hooked around it. Blocks hinged at the other end serve as feet and drop down when the bed is lowered.

The contrivance was made in an evening at a cost for material of only a few dollars and in several months it paid for itself many times.—FORD A. CARPENTER, Los Angeles, Calif.

A Self-Lubricating Bearing

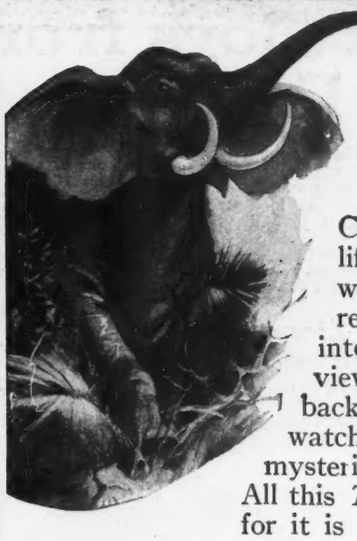
A SMALL bearing that is hard to reach for lubricating can be made to take care of itself, often for months at a time, by the simple expedient of drilling an oil hole at the top much larger than usual, filling it with a piece of felt or wicking that fits rather loosely, and weighting the top of the felt with a recessed lead weight to keep it pressed down on the shaft. Once the wick is well soaked with oil, the lubrication of the shaft will be maintained automatically for a long time and there will be no dribbling of oil. Where the bearing wall is thin, it is a good plan to press into the oil hole a short piece of thin brass tubing to hold the wick.



Requires little attention

While not new in principle, except perhaps the weight idea, this plan is one that amateurs seldom use and it deserves their attention.

PARAFFIN applied as an end coating for lumber during air seasoning will prevent much of the checking and splitting, as it retards the drying from the ends.



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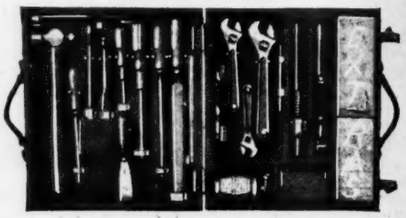
Ideal Toolkit for the Farmer—Chosen by College Experts

AFTER a careful study of the tool requirements of the average farmer, the Department of Agricultural Engineering of the University of California, at Davis, Calif., has designed the exceptionally compact and complete kit illustrated. It meets all ordinary field requirements for repairs to



Weighing only 24 lbs., this portable kit carries the essential tools for farm machinery repairs

farm machinery and other farm purposes and yet weighs only 24 lbs.

The tools in the kit are:

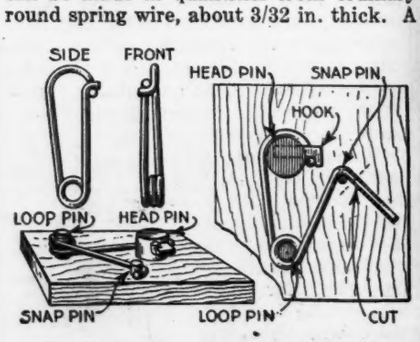
1-lb. ball peen hammer
6-in. extra slim three-corner file
8-in. round file; 10-in. mill file
6-in. screwdriver; 3-in. screwdriver
Putty knife
7-in. by ⅝-in. chisel
8-in. by ¼-in. punch; 6-in. by ⅜-in. punch
8-in. double calipers
3-ft. fourfold rule
6-in. slip-joint pliers
6-, 8-, and 10-in. adjustable end wrenches
14-in. pipe wrench; 12-in. monkey wrench
8-oz. oilcan and a grease can, with screw covers

The box, made in two halves hinged together, is 4½ by 15 by 17 in. The stock is ½ in. thick, with the exception of the bottom, which is ¾ in. Two 7-in. leather handles, one fastened to each section of the kit, are used. The hinges, hasps, and spring clips are standard hardware, but the guards for the ends of sharp tools and the various keepers are made of galvanized iron.

Bolts, nuts, and small extras are carried in a compartment 3½ by 1¾ by 17 in. This is closed by a sheet iron cover divided in the center, hinged at each end and fastened in the middle by a loop and cotter key.

Making Wire Snap Hooks

USEFUL for many varieties of strap and leather work, this type of snap hook can be made in quantities from ordinary round spring wire, about 3/32 in. thick. A



The hooks are made quickly by bending spring wire around a simple form

block is fitted up with plugs, as shown, to serve as a bending form.

A right-angle bend is first made in the end of the wire. It is slipped under a hook fastened in the larger plug and carried down and around the small plug three times, after which it is taken up and around the snap pin and given a sharp right angle twist. It is then cut off as indicated. The bends at the ends prevent the hook from pulling open under a heavy strain. These snap hooks will replace buckles.—J. V. P.

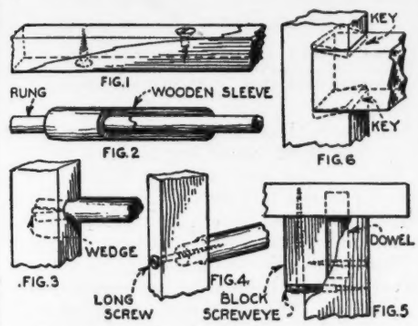
Light Duck Boat Made from

Tricks that Will Help You in Mending Furniture

THREE cardinal points to be borne in mind in repairing furniture are: First, that old glue should be removed wherever a new joint is to be made; second, that wherever a screw is inclined to be loose, it should be replaced with one a trifle heavier and longer; third, that no amount of glue will make a rung tight in a hole that is too large for it.

A rung or other member that is broken with a long taper (Fig. 1) can be satisfactorily mended by clamping the parts together, drilling and countersinking for screws as long as the wood will take, and finally gluing and driving the screws home.

A break straight across can be mended by boring a hole in a round wooden bar that



Five repairs that frequently are valuable in patching broken tables and chairs

fits tightly over the broken rung, and setting up with glue (Fig. 2). If a hardwood sleeve is used, this makes quite a strong joint, and if a lathe is at hand, the sleeve can be ornamented.

A rung can be tightened in a hole by splitting the end with a saw, fitting a small wedge, and driving home the rung with the wedge in place, all parts being given a coat of glue (Fig. 3). A rung subject to tensile strain can be made to stand up well by putting in a long, thin screw (Fig. 4).

How a hopeless-looking small table leg was mended is shown in Fig. 5. The leg was doweled to the top, and the wood had broken away, leaving most of the dowel exposed. A heavy screweye was turned into the leg just below the dowel, a block fitted between the screweye and the under side of the table top, and a screw put through screweye, block, and table top. With all the surfaces glued, this makes a better job than might be imagined, although it is necessary to see that the rungs and other braces are doing their work; the repair would not be satisfactory by itself.

A flat piece let into a rectangular recess, as the wood seat of a chair is often let into the legs, can be tightened in place by cutting out a rectangular key seat above and below, as shown in Fig. 6. This key seat is partly in one member and partly in the other. Keys fitting the space closely are driven in with glue, and the tendency is to bring the parts together hard and fast.

Fastening Watch Crystals

WATCH crystals frequently become loose and cause annoyance by falling out. A simple and effective way to fasten a loose crystal in place is to remove it and place drops of first class liquid glue in several spots in the grooved seat. Replace the crystal and allow the glue to set. Any surplus glue that squeezes out on the glass may be scraped off when dry.

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Keith's splendid Plan Books and Keith's Magazine on Home Building aid you in the most important part of all—starting right. Don't begin your new home or even plan it until you learn about this service!

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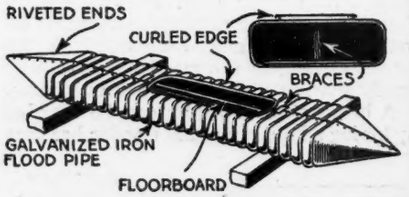
Write for details and price of CROWN—giving name and make of heating plant and approximate size of grate.

Light Duck Boat Made from Galvanized Flood Pipe

MADE at ridiculously low cost from galvanized flood pipe, this small duck boat was recently constructed by a Texas hunter. The boat serves its purpose admirably, and is a valuable addition to the hunter's outfit.

At a tin shop the builder chose a 10-ft. length of 24 by 30 in. corrugated galvanized flood pipe of the flat-sided type. The only



Costing only a few dollars, this unique boat of galvanized pipe carries three hunters and their camping equipment

other material needed was a few yards of light sheet metal, and a box of metal rivets.

The first job was to cut a 22 by 48 in. opening in one flat side of the pipe. This was done in a half hour, with tin snips and a metal saw. The rough edges were rolled.

The two open ends of the pipe were then closed with sheet metal cut to form a point at each end. The job of cutting and placing the ends was a tedious one, as much of the work was done from inside the pipe, but in three hours the ends were in place. The craft was then soldered airtight. Bulkheads fore and aft would make the boat almost unsinkable, but they were omitted.

After the boat was painted inside and out, wooden braces were placed in front and behind the opening and a floor grating and a small padded seat placed on the bottom.

Although oarlocks were fitted on the first boat built in this way, it was found that the boat responded well to paddles, and two Indian paddles were used. The entire cost was only a few dollars, and the actual work took six hours, yet the boat carries three passengers with bedding and supplies.

Hunter's Drinking Filter Can Be Carried in Pocket

IF THE hunter or fisherman does not carry a supply of drinking water with him, it often becomes necessary to drink surface water that may be contaminated. A compact drinking filter will lessen the danger from this source.

To make one, obtain a short length of tube about ¾ in. in diameter with one end closed. The end of a bicycle pump will be just right. In the center of the closed end, drill a small hole to accommodate a brass tube about 3/16 in. in diameter. Solder this tube into place with the end projecting 1 in. or less.

How the filter is made

Cut several disks of blotting paper to fit snugly in the large tube. Shove these to the bottom of the tube and fill the remaining space with packed absorbent cotton. Fasten to the smaller tube a stiff rubber tube so that it will not collapse under suction.

To use the filter, place the large brass tube in the water and draw up the water through the filtering elements by suction.—FRANK L. MATTER, Portland, Ore.

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Loop of Cord Will Tame Your Camera Tripod

A HAPPY group, a shady spot, and a snapshot click of the camera! A few days later the pictures are delivered, but those that should have contained the greatest interest—the subjects snapped in the shade—are dark and murky. In other words, those films are nearly transparent or underexposed.

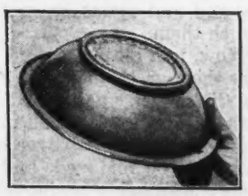
With the average camera and lens, snapshots of 1/25 second and faster are only possible when the subject photographed is sufficiently illuminated by direct sunlight. Amateurs are realizing this more and more

With this safety cord in place, there is absolutely no danger of the tripod's slipping

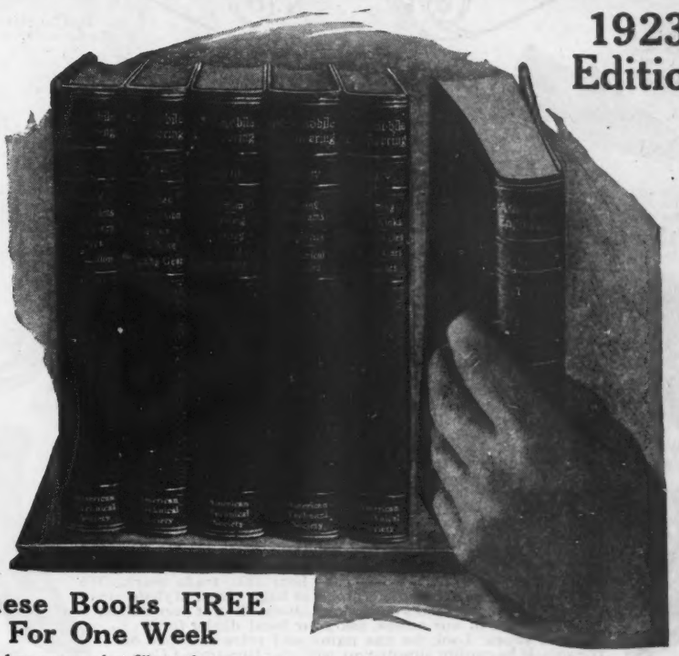
and are looking to the tripod not as a nuisance or as professional equipment, but as a necessary adjunct of the hand camera.

Tripods have a habit, however, of slipping when least expected, especially on smooth pavements and concrete roadways. The illustration shows a simple, inexpensive, and reliable method of keeping the tripod legs where they belong. I have used the scheme for several years, but it appears to be new to every one I have shown it to. The brace is simply a loop of heavy twine or cord. When the tripod is set up, the loop is slipped over the legs; the thumbnuts on each leg prevent it from slipping to the bottom.

Wire Ring Doubles Life of Tinware



UNTIL a month ago a shop in Pittsburgh wore out an average of three washbasins every two weeks. I finally recommended that a piece of copper or soft iron wire be soft soldered to the bottoms of the basins. This was done and, judging from the condition after a month's trial, the basins ought to last for several years.—J. H. S.



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How to Rebuild an Old Car

(*Continued from page 78*)

then necessary to press it off the shaft and replace it with a new one. Any end play in the transmission main and jack shafts is removed by inserting or removing shims, depending upon the construction. Where the main shaft joins the clutch shaft, a thrust ball is sometimes used and this may need replacing, as also may the bushing or bearing at this point.

The clutch should be carefully inspected, and doubtless will require relining. See that the clutch spring has good tension and that the thrust bearing in the throw-out collar is in good condition. Because of lubricating difficulties, this point is often worn and noisy. See that the clutch brake is in good condition.

When assembling or dismantling a clutch, the tension on the spring or springs causes the most trouble. By using a garage press, a vise, or even a jack, and blocking it, it is possible to compress the spring when dismantling or reassembling the clutch. When reassembling, see that all gaskets are renewed and proper provisions made for lubrication.

Universal joints require dismantling and the replacement of all worn parts. If they

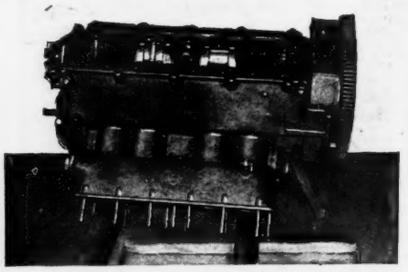

Fig. 5. V-type motor inverted for scraping and fitting the bearings

are allowed to run with worn bushings they place undue strain on other parts.

Now comes the work in which the most pleasure is always found—overhauling the engine. The first essential is to have the exterior of the engine free from grease and dirt. Then start dismantling by pulling off all accessories. It is well to provide a separate box for each of the units, such as the starter, generator, carbureter, and distributor, and drop into the box all the screws belonging to each unit.

Next remove the head, if it is of the removable type, and turn the block upside down (Fig. 5) and remove the crankcase pan. Drain the oil before turning over. Next, inspect the rod and main bearing assemblies to see that they bear identification marks. The usual method of factory marking is 1-1 for the upper and lower halves of the first connecting rods, and these marks usually appear on the camshaft side. The second rod will be 2-2, and so on. If the rod and mains are not marked, prick punch them.

Now, pull all piston and rod assemblies. Lay them on the bench in order, maintaining the shims as you found them. Pull the main bearing caps. You may need to pull the timing gearcase cover before the front main can be removed, and may find also some transmission or clutch part at the rear to be removed.

With the timing gears exposed, the marks on them are located. These usually are prick punch marks at the edge of the gears, so arranged that the engine is properly

(*Continued on page 109*)

How to Rebuild an Old Car

(*Continued from page 108*)

timed when they are brought together. If the gears are chain driven, arrow heads are at times used to indicate relative position.

Pull off the main bearing caps and lift out the crankshaft, so that the camshaft bearings can be inspected. The improve valves should be pulled previous to this operation.

With the engine entirely dismantled, the next step is an inspection of parts to see what must be replaced. In the case of the six-cylinder roadster shown in the first

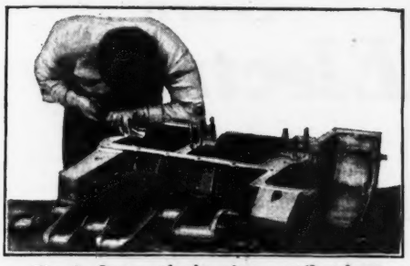

Fig. 6. Scrape the bearings until at least a 75 per cent bearing is obtained; then fit the caps

article of this series, the engine required 1 piston, 6 piston pins, 1 new valve, 12 rings, 1 main bearing cap, 1 oil line and 1 complete set of gaskets.

If the pistons can be made to show a rock on the pins, they should be renewed. Measure the piston clearance in the cylinders. If this is as much as .003 in. for every inch diameter of the piston, the pistons should be renewed. If the cylinder walls show light scores, use the old piston for a lapping tool and lap them out, as shown in Fig. 1, then fit the new piston with .001 in. clearance for each inch diameter. Piston clearance is measured with a thickness or feeler gage.

Mount the shaft on V-blocks and test for straightness. If sprung more than .002 in., it must be straightened in a straightening press or by means of a jack and chain.

Polish the shaft with emery cloth and if the journals show round within .001 in., the shaft may be fitted to the bearings (Fig. 5). First, take a light cut from the bearings in the crankcase. Next, treat with bearing blue and get an impression. Scrape until at least a 75 per cent bearing is secured, after which the caps are fitted, one at a time.

Each cap is fitted until it shows a good bearing and, when the cap nuts are all drawn down, it shows a slight yet positive drag on the shaft. Look out for false bearings and improperly fitted shims.

Rod bearings are scraped to a fit in much the same way. When getting the final impression, it is well to have the piston on the rod and assembled in the cylinder. An impression is secured by clamping the rod on the shaft and turning it with a bar. The high spots will show on the babbitt and as they are removed with the scraper, more and more surface is brought into contact with the shaft until a proper bearing is secured.

Each bearing will show a little drag and when all mains and rods are set up, the initial start of the engine will require a man on the crank, and another at the starter.

NEXT month Mr. Kuns will continue his suggestions on reassembling the engine, overhauling the vacuum tank, the gasoline system, the generator and ignition system, painting the car, renovating the top, curtains and upholstery, and tuning up the machine for use. —THE EDITOR.

"I will now kill the first man who crosses that line"

"Men," said the awkward old man who alone stood between the mob and their quarry—"I have tried to argue with you, and it's done no good. I don't know which one of you will kill me, but—*I will now kill the first man who crosses that line.*"

How Old Judge Priest, disregarding his political future and only means of a livelihood, challenged an armed mob of lynchers single-handed—because he believed there had been "a case of mistaken identity on the part of the bloodhounds"—and what happened to him as a result of his interference—makes one of the best short stories to be found in the English language. It is just one of 88 great stories by

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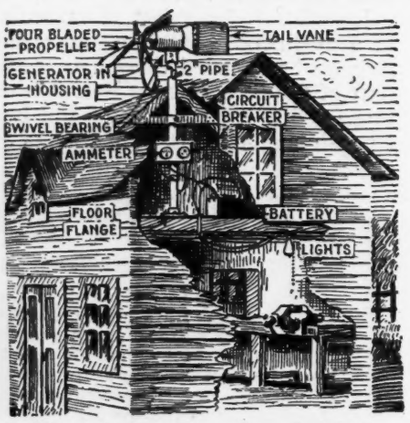
Lighting Your Shop with a Wind-Driven Electric Plant

By Robert S. Lewis

AT A surprisingly small cost for materials, any one handy with tools can construct a low voltage electric plant for lighting a shop, charging storage batteries, and similar purposes. This is accomplished by using standard automobile electric devices that can be purchased cheaply or salvaged from old or wrecked machines.

When selecting the generator, get one that has a third-brush arrangement for keeping the voltage uniform. This third brush, connected with one end of each field coil and also grounded, tends to decrease the efficiency of the field coils as the speed increases, and therefore makes the output more or less uniform for all speeds. It is, therefore, unnecessary to use clutches and



Mounted above the roof, a wind-driven automobile generator provides current for the workshop lights

governors to compensate for the variable speed of the air propeller or vaned wheel.

Either an old battery, if in fair condition, or a new one can be used, and an ammeter and circuit breaker also are required. The ammeter enables one to tell whether the generator is working at the best output for charging the battery, and the circuit breaker cuts the battery in and out as required. Without the latter, there would be a leak back from the battery when the wheel and generator are standing still or rotating slowly.

To simplify the construction, all gears and shafting are done away with. The generator is mounted on a flanged base, into which is screwed a short section of 2½-in. iron pipe. A two- or four-bladed propeller or a small wheel built on the familiar lines of an ordinary windmill wheel is carried on the extension of the armature shaft, to which it is attached by means of a pinned flange. Since the generators are equipped with ball bearings, the thrust of the propeller is taken care of automatically. The bearings are lubricated by packing them occasionally with a good grade of light grease.

The outfit is mounted on a standard of 2-in. iron pipes arranged to suit individual requirements. The ideal installation, as shown, is on the roof-top of a two-story shop or outbuilding. Standards can be stiffened against the beams, as required.

The short length of 2½-in. pipe attached to the generator pivots freely on the standard. The superfluous play is taken up by a double row of setscrews through the larger pipe. These are locked with nuts, as shown.

(*Continued on page 111*)

BOYS

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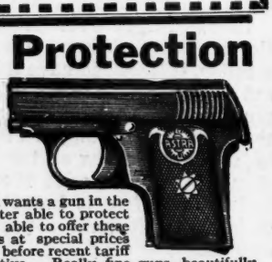

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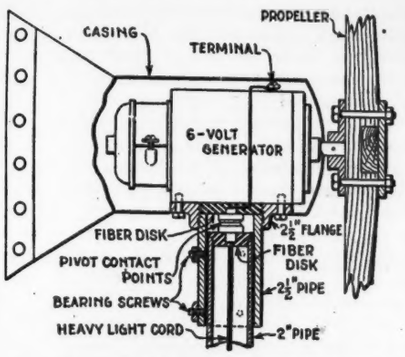
Lighting Your Shop

(*Continued from page 110*)

The weight is carried on two brass thrust pivots, each mounted in its own fiber disk. The upper pivot point is connected with the positive terminal of the generator by a wire passing through a groove chipped in the generator flange. The lower pivot connects with a wire leading down through the center of the pipe standard and passing out at the bottom through a hole bushed with a porcelain insulator.

The weight of the mill keeps it down on the pivot contact points at all times. The



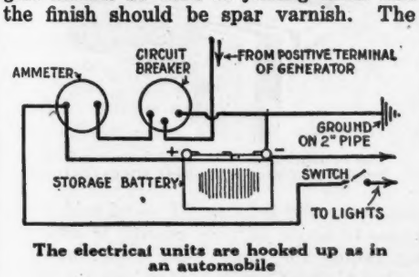
How the automobile generator is mounted on a pipe standard and provided with wind wheel and vane

setscrews make a sure contact for the grounding of the generator.

A weatherproof hood is made from a section of galvanized pipe, and the rear end is bent, as shown, so that the vane can be bolted to it. The semicircular front head of the casing is bolted or slipped tightly over the front of the hood, so that the interior will be water- and dust-tight.

In mounting the generator on its flange, take care that the screw holes do not enter too deeply.

My experience has been that the 24-in. four-bladed propeller—the blades about 3½ in. wide—provides ample power to drive the generator when the prevailing winds are fairly high and steady; if high winds prevail, a two-bladed propeller will suffice. The ordinary type of windmill wheel, built on a small scale, is much more efficient, however, if the winds are not strong and reliable. The builder should use his judgment as to which will best serve his purpose. The four-bladed propeller shown is made of two pieces of spruce, with a cross lap joint at the center. A good waterproof glue should be used in joining them and the finish should be spar varnish. The

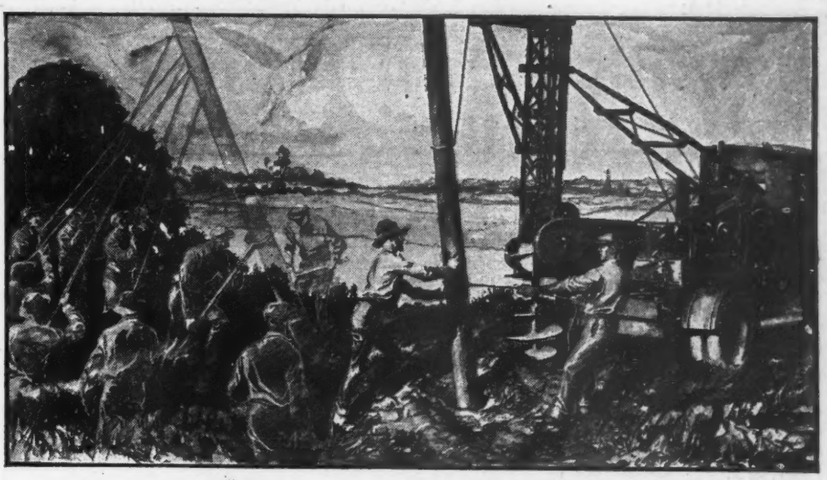


The electrical units are hooked up as in an automobile

propeller is bolted to the hub with 4¼-in. screws, and a steel plate or washer is clamped on the front surface of the propeller hub to prevent splitting.

The instrument board should be mounted near the battery, with the instruments arranged as shown. The wiring diagram above gives the hook-up.

(*Turn to page 112*)



Multiplying Man-power

To the man with pick and shovel the digging of holes for telephone poles is a slow and arduous task. Under favorable soil conditions three to five holes are for him an average day's work. Under adverse conditions perhaps he can account for only one. When the hole is dug, eight or ten men are required to raise the pole with pikes.

But the hole-borer with derrick attached, operated by only three men, can erect as many as eighty poles in a day—releasing for other telephone work upwards of forty men.

Hundreds of devices to quicken telephone construction, to increase its safety to the employee, and to effect economies are being utilized in the Bell System. Experiments are constantly being made to find the better and shorter way to do a given job. Each tool invented for the industry must be developed to perfection.

In the aggregate these devices to multiply man-power mean an enormous yearly saving of time, labor and money throughout the whole Bell System. Without them telephone service would be rendered neither as promptly, as efficiently nor as economically as it is to-day.

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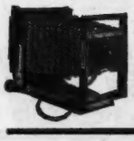

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Lighting Your Shop

(*Continued from page 111*)

The outgoing current is led down through the pivots and into the long wire in the pipe. From there, it enters the center binding post of the circuit breaker. A tap is then led out of the left-hand binding post to the ammeter. Two leads go from the ammeter, one to the positive terminal of the storage battery, and the other directly to the lighting circuit. The negative terminal of the battery is then connected with the other leg of the lighting circuit.

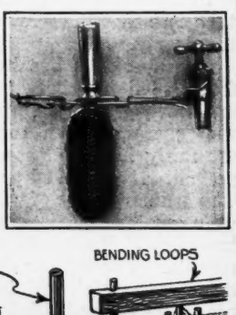
A tap is also run from the right-hand binding post on the circuit to a ground, so that when the generator is charging, but not heavily enough for the battery, a circuit is made for short circuiting the current; otherwise the generator wiring will be endangered.

The arrangement is practically the same as that of an automobile, and any one with a slight knowledge of mechanics can build and operate the set to perfect satisfaction. The specific gravity of the battery should be tested weekly to find out whether it is being fully charged. Add distilled water as required and keep the hydrometer and water bottle handy.

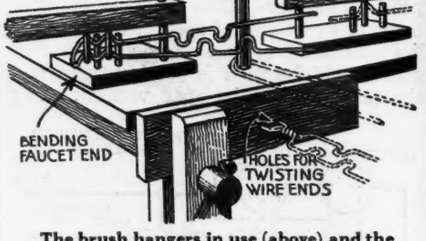
Wire the shop for low voltage sockets and bulbs wherever needed. Care should be taken not to waste the current by leaving the lights turned on when not actually required.

Brush Hangers Cheaply Made in Ingenious Bench Fixture

AFTER a six months' siege of typhoid fever, I recently found myself without work and in urgent need of money to meet household expenses. In this emergency I turned to my home workshop and made a number of sink brush hangers, as illustrated, in a simple bench fixture.



The hangers, made of No. 11 galvanized iron wire, are slipped over the sink faucets and hold dishcloths and brushes. These I sold from house to house, earning enough to support my family for more than four months.



The brush hangers in use (above) and the bending fixture for making them (below)

One of these brush holders can be made quite quickly with pliers, but to turn them out in quantities, I used the homemade press shown.—J. L., New Britain, Conn.

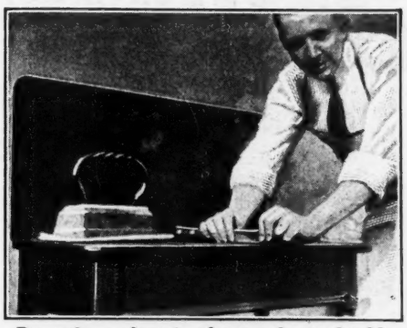
IT IS advisable never to put a brush away, even overnight, full of paint. A brush should always be cleaned of all surplus paint after use or its chisel edge will be damaged.

Waxing and French Polishing Old Furniture

By Gladstone Califf
School Superintendent, Richland, Iowa

WOULD you like to own choice pieces of furniture that grow finer and finer in appearance with the passing of years? It is neither costly nor particularly difficult to do so, provided you master the art of refinishing old pieces. Then you can buy or perhaps find in your own attic discarded pieces covered with dirt and cracked varnish and with a little work make them look as well or better than when they were new.

Dealers in antiques frequently refinish old pieces. The cost of refinishing even a simple old table may be as high as $15, but they consider it well worth the price. Any one who is willing to take pains to follow the directions below can put on as good a finish as the average antique furniture expert and at practically no cost except in time. I am confident of this because my own furniture has been finished in this way,



Removing a dent in the top of a card table with water and a warm iron, and scraping off the old varnish with a kitchen knife

and I have spent considerable time in refinishing furniture for friends who collect antiques.

To have the wood in perfect condition before applying any finishing material is most important in refinishing old pieces. The old finish, usually varnish, should be removed entirely. Scrape it from the flat surfaces with an old knife or scraper, and on the curved surfaces apply sal soda and water to loosen the old finish. It can then be scraped off with a stick made to fit the curves. A putty knife is useful for scraping and commercial or homemade varnish removers can be used as freely as seems necessary.

After the varnish is off, the wood should be washed with warm water and soap. When the wood is dry, the surface should be inspected carefully and any broken veneer replaced or patched. If you have no veneer and cannot obtain any easily, plane a piece of the same kind of wood rather thin, fastening it in place with hot glue, and, when the glue is dry, work it down with plane, chisel, razor blade and sandpaper.

Nail holes or screw holes may be filled with fine sawdust of the same kind of wood mixed with hot glue to a paste. Give the hole a thin coat of glue before applying the sawdust paste. When properly applied, this filler will not be visible. When the glue is set, pare the filler down to the wood with knife or chisel. If the hole is large, a piece of wood may be glued in place and planed down.

Large dents are another defect often found in old furniture, especially on table tops.

(*Turn to page 115*)

A Better Job Now!

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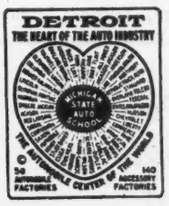

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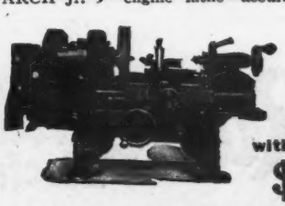

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Refinishing Old Furniture

Refinishing Old Furniture

(*Continued from page 113*)

These are taken out by moistening the wood around each dent, laying a thick piece of paper over the wet spot, and placing a warm but not too hot iron on it. The heat will bring the depressed surface up level.

Inkstains can be removed, if not too deep, by scraping, but it may be necessary to plane them out. After planing, scrape the surface with a steel scraper or piece of glass. When all the repairing is done, the wood should be sanded smooth with fine sandpaper.

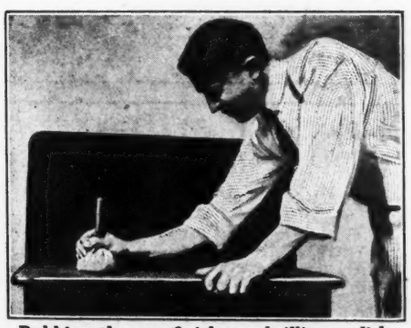
If the wood is not dark enough, or you wish to make it a shade to match certain other pieces of old furniture, it can be stained the desired color. Sometimes the wood is light in one place and dark in another. In that case the light places, which probably are sap wood, should be stained to match the body of the piece.

Making a Brush Container

In building up a good finish first class brushes and tools are necessary. It is well to provide a brush container made of a can not less than 8 in. high and 4 in. square, with a piece of wire running through it, as shown, to hold the brushes suspended in a keeper. For the shellac brush, this should be alcohol, and for varnish, turpentine. A brush that has been used in water stain needs to be washed well and kept dry.

My experience has been that the best stain to use for this work is water stain. Any standard commercial stain may be used. I buy mine in powder form and mix it with water. Care must be used in water staining veneered work, however, because carelessly applied stain may loosen the veneer.

The stain will raise the grain of the wood. To overcome this drawback it is a common practice to moisten the wood with warm



Rubbing the wax finish to a brilliant polish with a homemade polisher, which is simply a cloth pad and a wooden handle

water first and then sandpaper down the raised grain before applying the water stain. I simply allow the stain to dry—two coats of it, if necessary, to get the desired color—and apply a thin coat of white shellac on white work, or orange shellac on dark work. After this has dried at least 12 hours, I sandpaper it with fine paper to cut off the grain raised by the stain.

Old furniture that has been finished contains some filler in the pores of the grain, but after the varnish is removed, it is better to add more filler before refinishing. For instance, in refinishing a walnut piece, brush walnut paste filler across the grain, wait a few minutes for the gloss to disappear, and then wipe it off across the grain with a piece of burlap or some shavings. Do not wait too long before wiping because the filler gets as hard as stone. After 24 hours

(*Continued on page 116*)

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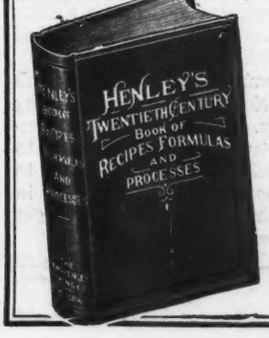

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Refinishing Old Furniture

(*Continued from page 116*)

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Refinishing Old Furniture

(*Continued from page 115*)

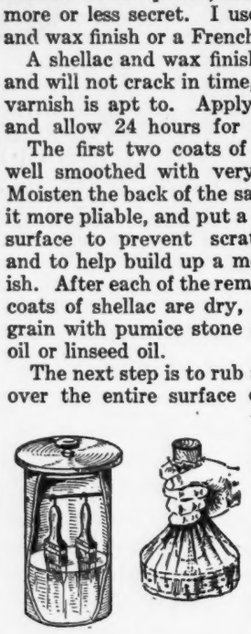
you may sandpaper the surface smooth.

Expert furniture refinishers seldom use varnish on old pieces, and their process is more or less secret. I use either a shellac and wax finish or a French polish.

A shellac and wax finish is very durable and will not crack in time, as even the best varnish is apt to. Apply the shellac thin and allow 24 hours for drying.

The first two coats of shellac may be well smoothed with very fine sandpaper. Moisten the back of the sandpaper to make it more pliable, and put a drop of oil on the surface to prevent scratching the finish and to help build up a more beautiful polish. After each of the remaining four or five coats of shellac are dry, rub it across the grain with pumice stone and pale rubbing oil or linseed oil.

The next step is to rub a thin film of wax over the entire surface of the wood. It should be rubbed on with enough friction to melt the wax.



The brush keeper and wax polisher

To assist in applying the wax screw a 5-in. handle to the center of a ⅞-in. board, 4 in. in diameter. and tack a piece of lintless cloth halfway round the edge of the circular piece. Make a cloth pad from another piece of cloth, place it under the covering piece and carry the loose end up so that it can be held tightly. This tool should be rubbed with and across the grain with great pressure.

After the wax has dried for 24 hours, polish it with a cloth and put on another coat. A third coat will make a still better polish.

A heavy flatiron wrapped in a piece of carpet will aid in polishing flat surfaces. Curved portions can be polished with a cloth held in the hand. Table legs can be polished with a long strip, as a bootblack polishes shoes.

A wax polish has the advantage that it can be renewed from time to time with more wax. When the film of wax hardens it forms an attractive coat that is so durable it can hardly be removed, much less worn off.

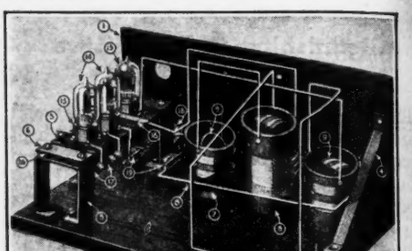
For French Polishing

More difficult to apply, but especially beautiful, is a French polish. For brilliancy and transparency it probably cannot be equaled.

After the wood is stained and filled, apply a thin coat of orange shellac with a brush. The rest of the polish is rubbed on with a rubber made by twisting a piece of soft cloth into a wad and covering it with a larger piece that is absolutely free from lint. The inside cloth is dipped in shellac from time to time. Twisting the larger cloth forces a small quantity of the shellac to ooze out of the surface, and this is rubbed over the wood with a circular motion.

Practice and caution are required to rub a surface to a perfect finish without leaving any uneven spots. The rubber is occasionally touched with a drop of linseed oil to prevent it from sticking. Never allow it to stand on the wood; keep it constantly in motion. Care must be taken not to get

(*Turn to page 117*)



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Refinishing Old Furniture

(*Continued from page 116*)

either too much shellac or too much oil on the rubber, and it is best to rub only a small surface at a time.

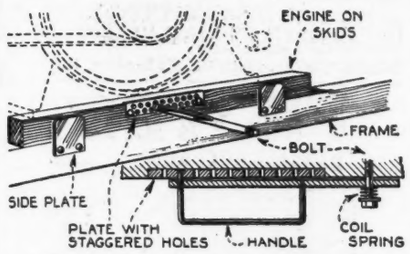
After the wood has absorbed all the shellac you think possible, let it dry for 24 hours and then apply more. Keep this up for four or more applications.

The last step requires the utmost caution. It is called "spiriting off." A small piece of cloth is moistened in alcohol and rubbed over the wood to level and smooth up the surface. Do not get too much alcohol on the rag or you may take off the entire finish. Moisten the cloth in alcohol and touch it to the back of your hand; it should feel only slightly moist. Finally, rub the wood all ways of the grain with a silk cloth.

The luster and beauty of a finish made by either of these methods will not fade in a lifetime of use.

Making a Simple Belt Tightener for Portable Machines

WHEN small gasoline engines on hand skids are used to operate portable saws and other machinery mounted on the same frame, and the skids slide between side plates on the frame, it usually is difficult to keep the belt tight and make the necessary belt adjustments. How one man



How the tightener is used and a sectional view showing the details of its construction

solved this problem is shown in the accompanying illustration.

The main member of the belt tightener is a length of flat stock with a hand grip, made as shown, so that one end projects like a pin on the other side of the bar for an inch or two. A plate bearing two rows of staggered holes is sunk flush in the upper edge of the engine skids. The belt is tightened by sliding the skids along the frame, and the lug of the tightener is dropped into a center hole and the tightener fastened with a lag screw to the frame. Under the head of the lag screw is placed a washer and a spring to keep the lug properly seated. A considerable range of adjustment is then possible by placing the tightener lug in the various holes.—L. S.

How to Wash Your Auto

TO WASH an automobile properly, begin with the wheels and under side of the fenders, using a gentle stream of water that does not carry more than 6 in. from the end of the hose. Wash off any oil spots with a sponge and soapy water, but rinse immediately.

The chassis completed, flow off all the dust on the body, and then wash the body with a wet sponge. Squeeze the sponge dry, remove all superfluous water, and dry the body with a chamois skin.

Finally, wash the hood and radiator top, drying them with the chamois skin.—C.L.A.

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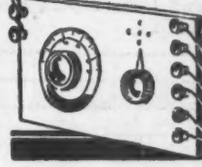

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aerial cascade		capital ship
junior college		Blue Cross
Czecho-Slovak		royal spade
Devil Dog	Waac	broadcast
overhead	realtor	photostat
Flag Day	bloc	nose dive
agrimotor	soviet	stop back
irredenta	nacelle	narcism
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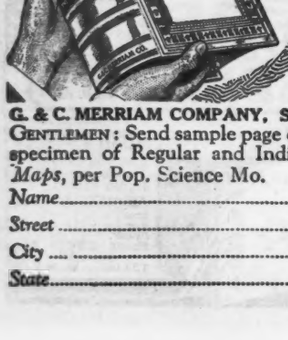

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"The Rower" Is a Unique Mechanical Cigar-Box Toy

By Capt. E. A. McCann

TURN the handle of this toy—the man rows and the waves heave with surprising realism. Although the lifelike action seems complicated and somewhat puzzling, the toy is really simple, and any one who is handy can make it without special tools or any expense worth mentioning.

You will need two cigar boxes, each 2½ in. deep. Take the bottom off one, and in the lid cut three or four slots, as indicated in Fig. 2, almost the full length of the box

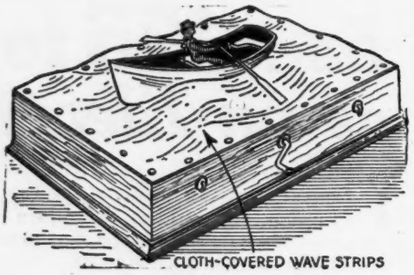

Fig. 1. When the crank is turned, the man rows and the waves move up and down and roll forward realistically

and wide enough to allow a slip of wood cut from the lid or sides of the other box to be inserted in them. The slip should work up and down easily.

Cut three slips altogether and shape them as shown in Fig. 3, the top edges representing wave crests. Two holes are drilled in each to take the cranks, and the center curve at the bottom is made to clear the middle crank. The slips must be shorter than the slots by the length of the throw of the cranks.

Next, make the shafts from fairly heavy stiff wire; they should be shaped as shown in Fig. 2. The center one has a small crank in the middle and another at one side to move the other cranks through the connecting rod.

The connecting rod is a piece of metal. A strip of tin from a can will do if it is doubled over to make it quite stiff. The holes for the three cranks must be drilled accurately after they are in position. The center crank does not connect at all with the waves and, of course, the handle can bend up at either end, or handles can be placed at both ends, if desired.

Each of the two end shafts is bent so that the cranks connecting with the wave slips are at right angles to the crank for the

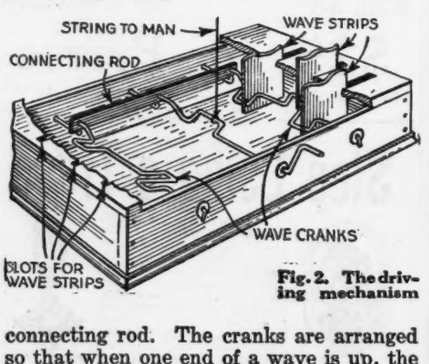

Fig. 2. The driving mechanism

connecting rod. The cranks are arranged so that when one end of a wave is up, the other will be down.

Slip these shafts through the holes in the waves, place the waves in their slots, and then bore holes accurately in the sides of the box for the shaft bearings. Ease out

(*Continued on page 119*)

Posed by Miss Ann Forrest, Famous Movie Star, and Arthur Murray, the Vanderbilts' instructor

Why Good Dancers Are Popular

THOUSANDS of men and women are compelled to pass up many a good evening's fun just because they don't know how to dance. Yet there is no need for anyone to be a wallflower. Arthur Murray, America's foremost authority on social dancing, has perfected a method by which you can learn the steps of any of the latest dances in a few minutes. You don't need to go to a dancing class—you don't need to take private lessons—you don't need to bore your friends by getting them to teach you. Through Arthur Murray's method of easily understood diagrams and simplified instructions you can quickly learn to become a perfect dancer right in the privacy of your own room without either music or partner. And just as quickly as you have mastered the steps you can dance perfectly on any floor to any kind of music and keep step or follow correctly with the best dancer in your set.

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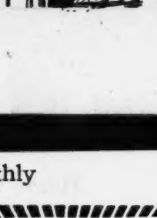

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How to Make Simple Cranks

World Radio

"The Rower" Is Unique Toy

(*Continued from page 118*)

one side of the box and get them in. The ends of the cranks may be clinched over washers to steady them.

From a piece of soft wood cut a small flat-bottomed boat about 3 in. long; hollow it out and make it as neat and complete as you wish. If you prefer, build it from bent cigar-box wood. Also make a small figure of a man, either flat (out of cigar-box wood) or carved (from a stick). Glue or screw him on the seat to fit the middle of the boat and fasten this in position by means of a pin through the gunwale on either side so that the seat will swivel easily. The figure should be sitting upright or bent a trifle forward, with his heels on the bottom of the boat.

Make a pair of oars and fasten them to the figure's hands with wire rings. Put staples in the gunwales to represent oarlocks and see that the oars work easily.

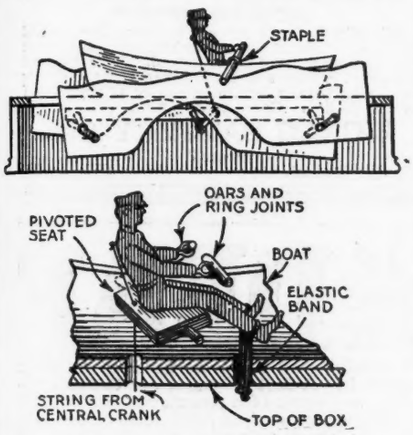

Fig. 3. Details show how the wave slips are shaped and the rower's figure is mounted

Also bore two holes through the bottom of the boat and top of the box (Fig. 3).

Pass an elastic band over the toes or around the ankles of the figure and fasten it to a staple inside the box. As far back as possible, fasten a light string—fishing line for preference—to the shoulder of the figure, pass it through a hole in the seat and down into the box. Connect it with the center crank with a wire loop, for which it is advisable to file a small groove in the crank. This groove will prevent the loop from slipping from the center. The string should be of such a length that when the crank is down, the man leans well back. If your crank should be too long, leave the string slack; if too short, make a new crank.

On turning the handle, all three shafts revolve. The cranks of the end shafts cause the waves to move up and down with a forward movement. The center crank causes the man to move backward and the elastic pulls him forward again.

Paint the toy to suit your taste, and it is then complete in its essentials. An evening's work is sufficient to make the whole thing. While a fretsaw is handy, a sharp pocketknife will do the cutting, and a square-nosed pliers will aid in making the cranks. These are best hammered to right angles against a sharp piece of iron.

You may add many refinements such as modeling the man artistically and passing the string up through his body instead of back of him. If you cover the box with light blue cotton cloth over the waves and under the boat (Fig. 1) and glue it or tack it to the sides of the box and to the wave tops, leaving it slack, the waves appear very real.

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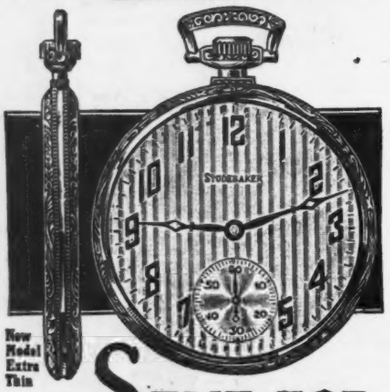

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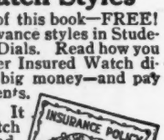

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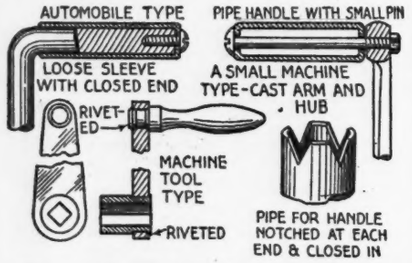
How to Make Simple Cranks and Crank Handles

MANY automobile cranks are bent from round steel stock and fitted with a pin for engaging the notches in the fan pulley of the engine. These cranks usually have a plain hand grip, so that one is apt to get blisters when spinning the motor for any length of time. To overcome this, the writer has fitted his own crank, as well as those of his motoring friends, with loose sleeves, as shown.

The sleeve is a length of thin brass tubing. Notches are sawed in one end of the tube and the prongs are bent to leave an opening that is filed out to fit loosely over a bottomed screw with a large head.

When the wooden handle of the corn sheller, the washing machine, or any other small hand-operated machine splits or breaks, it can be replaced in a somewhat similar manner with a pipe sleeve handle. A short section of pipe is notched at each end, as shown, and these ends are then closed in, leaving a hole for the through bolt that forms the spindle of the crank. Handles of this type have a good grip and will outwear the rest of the machine. They should be oiled occasionally.


AUTOMOBILE TYPE
PIPE HANDLE WITH SMALL PIN
LOOSE SLEEVE WITH CLOSED END
A SMALL MACHINE TYPE-CAST ARM AND HUB
RIVETED
MACHINE TOOL TYPE
RIVETED
PIPE FOR HANDLE NOTCHED AT EACH END & CLOSED IN

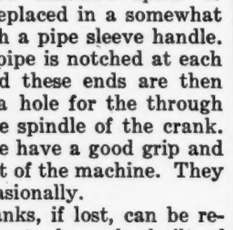
Three easily constructed crank handles for automobile or machine use

Machine tool cranks, if lost, can be replaced with neat, rugged cranks built of flat and round steel, as illustrated. A long tapered arm or crank web is fitted at its upper end with a handle turned to shape and riveted in place.

The hub or the eye is also turned up out of round steel and has a shoulder that fits against the web. The end of the hub that projects through the bore of the web is riveted over to hold the parts firmly together.—L. F. C.

Fastening an Umbrella Handle

MY METHOD of fastening a wooden umbrella handle to the steel rod is as follows:



Take a wood screw that has a shank a trifle larger in diameter than the inside of the hollow metal rod and saw off the head of the screw. Heat the rod with a blowtorch or hold it in a gas flame until it becomes red hot. Then quickly insert the shank of the screw in the end of the rod and immerse in cold water. The screw will be fastened securely by the shrinkage and it can then be screwed into the wooden handle. It will be practically impossible for the handle to come off unless it is unscrewed.—JOHN F. JOB, N.Y.

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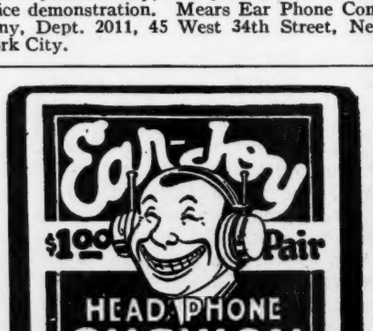

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How to Build a Long-Distance Broadcast Receiver

By Arthur L. Munzig, 6ZJ

Formerly First Class Radio Electrician, United States Navy

IF YOU are interested in obtaining long-distance records with a simple one-tube receiver, I can recommend confidently the type of set I have been using at my own station, 6ZJ, at Redlands, Calif., since before broadcasting became popular. With it I have heard repeatedly WJZ, Newark, N. J. (now New York), 2500 miles away; CFAC, Calgary, Manitoba, Can., and KDKA, Pittsburgh, Pa., each about 2300 miles away; KDYX, Honolulu, Hawaii, 2200 miles; WMAQ, Chicago, Ill., and WSB, Atlanta, Ga., both 2000 miles; WOC, Davenport, Ia., and WDAF, Kansas City, Mo., both 1400 miles; KFBJ, Boise, Idaho, and WPA, Fort Worth, Tex., both

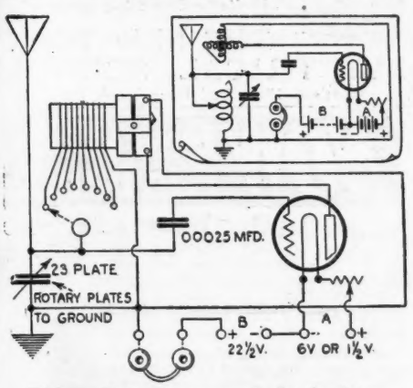

Fig. 1. Two diagrams of the hook-up for a long-distance set, one conventional and the other simplified for the beginner

1200 miles; KDYS, Great Falls, Mont., 1100 miles; KFAF and KLZ, Denver, Colo., KGW and KGG, Portland, Ore., KDZE, Seattle, Wash., all approximately 1000 miles away. Many other stations have also been heard, but they are so close that they are not of much importance from a "DX" standpoint.

The circuit is shown in Fig. 1. It will be seen that the inductance coil and the variometer are in juxtaposition. By thus coupling the grid and plate circuits the radio frequency currents are taken advantage of to increase the strength of signals and incidentally to aid selectivity. The set oscillates and regenerates over the whole range of accessible wave lengths.

Because this is a single circuit receiver do not think that undesirable signals cannot be tuned out. While it is not equal in selectivity to a three-circuit receiver, it is, in my opinion, superior in selectivity to any of the conventional single-circuit designs commonly used. In signal strength it has a considerable advantage over a three-circuit set with only one tube.

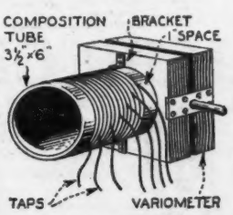

Fig. 2. The inductance coil and variometer

The materials necessary for assembling the receiver are:

1 variometer
1 composition or fiber tube, 3½ in. in diameter, 6 in. long
¼ lb. 22 D.C.C. copper wire
8 switch contact points
1 switch knob and arm
1 grid condenser

(*Turn to page 122*)

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Building a Broadcast Receiver

(*Continued from page 121*)

1 23-plate variable condenser
8 binding posts
1 composition panel, 3/16 by 7 by 18 in., or similar
1 vacuum tube, any standard type
1 socket to suit tube
1 A battery, storage or dry-cell, to suit tube
1 rheostat to suit tube
1 B battery 22½ to 45 volts
2 3-in. dials and knobs
1 telephone head set
1 piece of wood for base

No appreciable difference will be noticed between a storage battery or a dry-cell tube.

The combination inductance-variometer unit is shown in Fig. 2. The tube is wound with 80 turns of the No. 22 wire, a tap being taken at every tenth turn, by the usual method of twisting a small loop. Two small brass angles are used for fastening the inductance coil to the left side of the variometer. This completes the tuning circuit.

The panel layout and the relative position of the instruments are shown in Fig. 3. In making the connections, I used bare copper wire not larger than No. 14, in preference to tinned bus bar.

To operate, connect the antenna lead with the extreme left-hand binding post, and

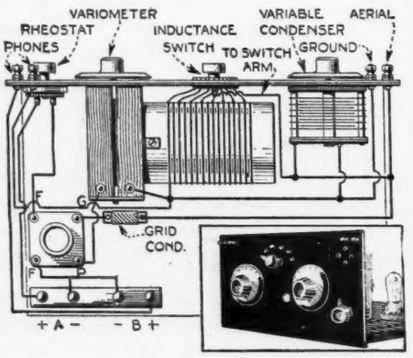


Fig. 3. How the parts are arranged and wired, and the appearance of the finished panel

the ground lead with the post alongside. Then connect the A and B batteries with their binding posts at the rear of the base. These posts should be mounted preferably on a strip of fiber and not directly on the wood. Usually the 18-volt tap of B battery is used, but the voltage varies with different types of tubes.

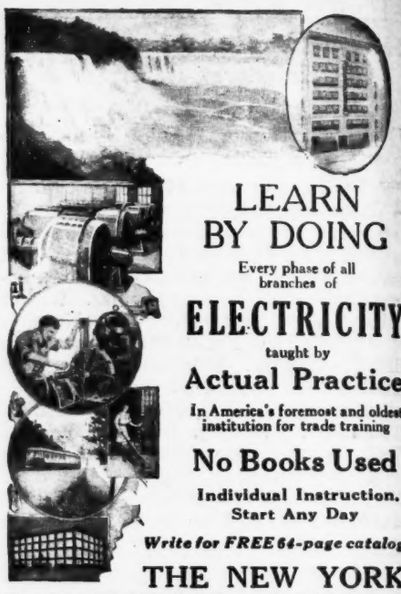
Slowly turn the detector tube rheostat about three quarters as far as it will go. Connect the telephones with the binding posts provided for them at the right of the panel, try the antenna inductance switch on the various contact points, and turn the variable condenser very slowly from minimum to maximum until signals are heard to best advantage.

To increase the intensity of signals, turn the variometer control to a point where distortion will begin if the dial is moved another degree. How to make the correct settings will quickly be learned with a little practice.

If, after connecting the receiver, it refuses to regenerate on wave lengths of more than 600 meters, reverse the connections with the variometer. It is also well to try reversing the A battery connections.

The utmost pains should be taken in assembling and wiring the set, in order to obtain the best results. One slighted detail may cut down the efficiency considerably.

The writer, being an old ship operator, enjoys listening to the 600-meter traffic, and this set performs perfectly on the wave lengths used for these messages.



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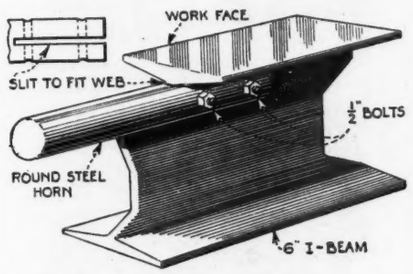
I-Beam Anvil Cheaply Made for the Small Shop

A SERVICEABLE anvil for the home or farm shop can be made from a piece of scrap I-beam and a short length of round steel. The I-beam usually can be picked up in any structural steel shop for a few cents a pound. It is cut to the shape indicated with a hacksaw and the edges are rounded with a file.



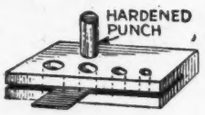
For the farm or home shop, this inexpensive anvil serves for many purposes

The horn is slotted to pass over the central web and rests on the projecting front support, as shown; two ½-in. bolts hold the horn to the anvil proper.

If a tapered horn is desired, take the round iron to a blacksmith's shop and have it forged to a taper. For ordinary use, however, a straight horn serves very well and it can be made in any length to suit special jobs. A long horn makes an ideal riveting anvil for tinsmiths in working up tubes and pipes.

The anvil can be fastened either to a workbench or to a regular anvil base with railroad spikes.—J. R.

A Quickly Made Punch



PUNCHES of various sizes are often useful about the workshop. The writer recently made a set of five punches by the method illustrated. A slot was cut in a steel plate with a hacksaw and the holes were drilled through. The punches were made of drill rod with hardened ends.

The sheet metal is placed in the slot and the punch is struck a sharp blow with a hammer. This is sufficient to punch holes in 20-mill stock.

How to Increase the Range of a Small Magnet

IN THE course of some experimental work it became necessary to arrange an electromagnet to exert a considerable pull through a distance which was great as compared with the magnetic field at the poles. The magnet was required to raise a spring-loaded arm through a distance of about ⅜ in., but if it had been made large enough to do that, it would have had an enormous excess of pull when the armature was close to the poles and it would also have been too bulky.

The problem was solved by using a small magnet that had ample magnetic pull at a distance of ⅛ in. from the pole, and the motion was magnified through an L-shaped lever, the long arm of which had a maximum motion of ⅜ in. This idea undoubtedly will be useful to experimenters who meet similar problems, for it saves space, weight, wire, and current and at the same time is easily applied.

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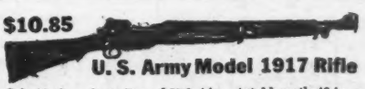

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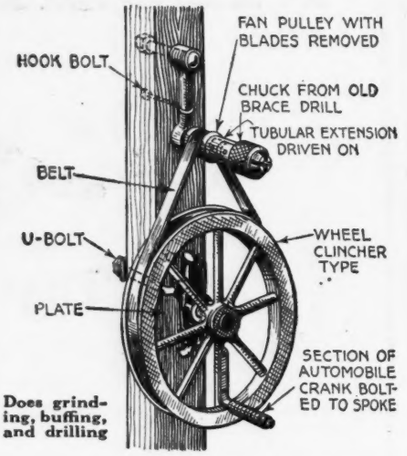
Auto Wheel and Fan Pulley Form Grinding Fixture

A DRILLING, grinding, and buffing fixture can be constructed at little cost by using a flanged fan pulley, a clincher type automobile wheel, a ball-bearing spindle, a crank handle, and the chuck from an old brace. With the exception of the last, these are junk parts from a Ford or other light type automobile.

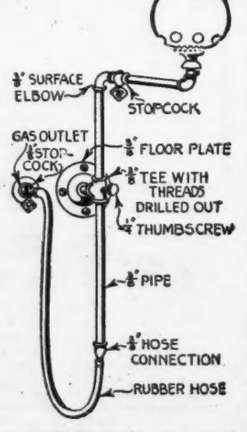


The wheel is mounted on the spindle and the crank is fastened with bolts to one of the spokes. The fan pulley is mounted on a fan frame bracket. Both these members are bolted in place, as shown, on a wooden column rigidly supported on the shop floor. A leather belt drives the fan pulley, the hub of which is extended by means of a length of pipe for holding the chuck.

Adjustable Bracket for Gaslight

IN THE workshop that is lighted by gas, it is often difficult to get the proper degree of illumination on fine work at the bench. An adjustable bracket like the one illustrated will usually solve the problem, because it permits the light to be moved up and down and swung to one side or the other as necessary.

Drill the threads out of two ends of a ⅜-in. beaded tee, so that a ⅜-in. brass pipe will slide through snugly. Drill a ¼-in. hole in the tee and tap it for a thumbscrew to lock the pipe, as shown. Connect a hose stopcock where the bracket was originally connected with the wall, so that when the gas is shut off there, the hose will be relieved from pressure. Screw a ⅜-in. floor plate to the wall with a short nipple for the tee.



For workshops lit by gas

The gas bracket is fastened to one end of the sliding pipe with an ell, and a hose connection is screwed on the lower end. A length of gas tubing completes the connection. It is perhaps better to omit the bracket stopcock entirely.—L. H. VOTE.

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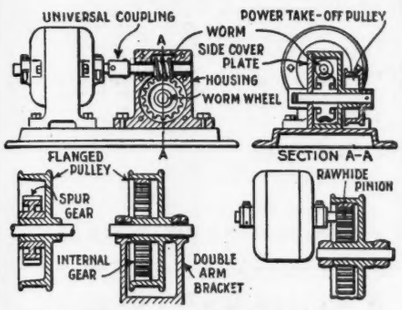
How to Install Speed Reduction Gearing for Small Motors

By Joe V. Romig

IN USING electric power to drive small machines, the need for an elaborate speed-reducing system of belts and pulleys can often be avoided by utilizing one of the gear drives illustrated. These gear reductions are easily installed, and are neat and satisfactory, especially where space is at a premium.

Washing machines, grindstones, and the like are run at low speed and can be belted direct to a speed-reducing unit, provided that it is designed to give the correct number of revolutions. For very slow speeds the worm and worm wheel are used. The shaft ratio being known, a suitable worm



Three types of reduction units using worm, spur, and internal gearing

and wheel can be bought from a gear manufacturer. The worms and their mating worm wheels can be bought in single, double, triple, and quadruple threads, and almost any range of speed can be provided.

Worm gearing should run in an oil bath, and the casing, therefore, should be made oiltight. One of the best ways of accomplishing this is to build a simple pattern and have the housing cast at a local foundry.

A universal coupling is necessary and every care should be taken to aline both shafts accurately. The power take-off pulley should be of the double flanged type, broad and strong, and of such a design that it overhangs the bearing, as shown.

For intermediate or medium speeds an internal gear and rawhide pinion are used; for half motor speeds, a spur pinion and gear will serve. In both cases a bracket with double bearings is used to support the power take-off shaft. The bracket should be fastened securely to a cast iron base and doweled to prevent it from twisting out of alinement with the motor shaft.

In case a spur gear reduction is used, it is advisable to use a rawhide or fabric pinion on the motor shaft to give a quiet and noiseless running.

Emergency Developing Trays

DEVELOPING trays for either photographic or blueprint work can be made in an emergency from shallow wooden or even cardboard boxes. One method is to coat the box inside and out with hot paraffin wax; the other is to use black asphaltum varnish. The asphaltum makes a good looking as well as serviceable tray.

A cigar box can be used for a small tray by driving a few extra brads into it, giving it a thin coat of asphaltum and alcohol or asphaltum and turpentine and then pouring the thick asphaltum in and running it around until the interior has been thoroughly soaked.—CORA HAMILTON.

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WELL! WELL!
LA-LA SCROOF LA DE DA KRRR KKK
A LITTLE FLAT
SCRRR BRRKK KKKK KKK
WOW HER VOICE IS CRACKED TURRIBLE
O-BUT SHE'S A MILLION DOLLAR STAR ED!
HM NOT 'NUF JUICE BATTRY'S LOW.
NOW WHERE Y' GOING, ED!
AWR!
I'LL MAKE HER SOUND LIKE A MILLION DOLLARS— I'LL GET A—
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The Elto is the most powerful light weight motor, the lightest motor per horsepower. It starts as easily as striking a match because it has a big hot spark independent of cranking speed and for the same reason it can be slowed down to real fish-getting trolling speed. Rudder steering. No dangerous pivot turning! Tiller rope control from any part of boat. No shaky, vibrating steering handle. The only 3 H.P. light weight motor—a full *extra* horsepower over other lightweight motors, the needed H. P. for substantial boats—to buck wind, waves, currents and tides or sudden storms.

Send for catalog—an enlightening booklet—not merely a picture book.

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Elto

Repairing the Cracked Top of a Hollow Tool Handle

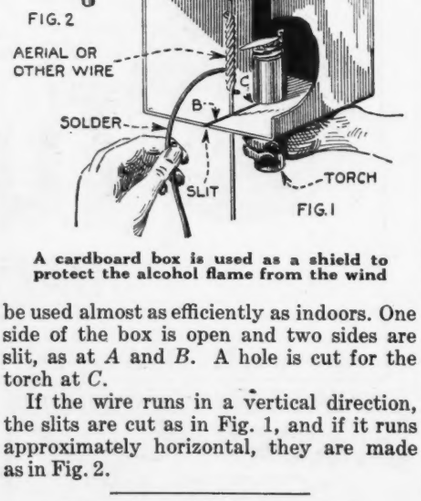
USUALLY the first thing to break in a hollow-handled toolset is the wooden screw top, and without the handle the tool is of little use. Such a break can be repaired, however, in such a way that the top will actually be stronger than when new.

Wire binds the parts together

Cut a wide, shallow groove around the top at its greatest diameter, apply glue to the edges of the break or cracks, and bind the top together with a smooth, even layer of copper or brass wire of about No. 20 gage. Cut a small groove in the crack, as it were, so that the starting end of the wire can be nipped in the crack without holding the parts away from each other. Finish off the winding by passing the end of the wire twice around the turn that is next to the last and pulling it tight.

To Solder an Outdoor Aerial in Windy Weather

WHEN outside wires, such as a radio aerial, are to be soldered in windy weather, it is impracticable to use an alcohol torch, and often not convenient to use a regular or electric soldering iron. In this event a cardboard box 8 by 10 in. square will serve as a screen to protect the flame of the alcohol torch, and allow it to



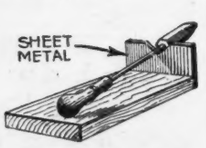
A cardboard box is used as a shield to protect the alcohol flame from the wind

be used almost as efficiently as indoors. One side of the box is open and two sides are slit, as at *A* and *B*. A hole is cut for the torch at *C*.

If the wire runs in a vertical direction, the slits are cut as in Fig. 1, and if it runs approximately horizontal, they are made as in Fig. 2.

Rest for Soldering Iron

TO PROVIDE a convenient place for my hot soldering "iron" when I have put it down for a moment, I use the stand illustrated. This is merely a piece of metal with a V cut in it screwed to the end of a wooden baseboard.—C. F.



WHEN cutting and fitting new windshield glass, a smooth edge is obtained by finishing the cut edge with an old or broken piece of emery wheel.

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Adding a Radio Frequency Unit

(*Continued from page 80*)

A is connected with the top end of the stator winding of V_1 and with the *G* terminal of tube socket *1*.

Now connect one rotor lead of V_1 with the switch arm of switch *B*, one lead of the V_2 rotor winding with the switch arm of switch *C*, and one lead of the rotor winding of V_3 with the switch arm of *D*.

Connect the other rotor lead of V_1 with post *J*. The remaining rotor leads of V_2 and V_3 are joined and then connected with *F* and *I*.

Next connect the terminal of C_1 that is nearest to tube socket 1 with the *P* terminal of that socket and run another wire from the same terminal of the condenser to the top end of the stator winding of V_2. Make the same connections between similar terminals of C_2 and variometer V_2 by connecting one terminal of C_2 with the *P* terminal of socket 2 and the top end of the stator winding of V_2. The remaining terminal of C_1 is connected with the *G* terminal of tube socket 2 and the remaining terminal of C_2 with the *G* terminal of tube socket 3.

The Shields Are Grounded

The *P* terminal of socket 3 is then connected with *E* and the wiring completed by connecting the metal shields together and with post *J*.

If the unit is to be connected with a double circuit set, no changes in the wiring of the set are required. Make sure, however, that the primary circuit is not connected in any way with the other circuits of the set. If the set you are using is of the single circuit type, the grid leak, instead of being connected across the condenser, should be connected so that one terminal connects with the *G* terminal of the detector tube socket and the other connects with the positive A battery lead. Instead of a direct connection between the ground and the filament circuit, a .001 mfd. condenser should be connected between the ground and the filament circuit.

Since the negative end of the B battery is already connected with the A battery lead, no connection with the negative of the B battery is required from the radio frequency unit.

When the radio frequency unit is to be used, it can be placed either beneath or on top of your standard set and the connections to aerial and ground post of the set made as explained in the beginning of the article. If the use of the radio frequency unit is not desired, disconnect the connections from the aerial and ground posts of the standard receiver and connect the aerial and ground to the standard receiver instead.

Brings in Distant Stations

After a few evenings' experimenting with the set you will have no difficulty in tuning in stations 1000 miles distant, loud enough so that with the use of the two stages of audio frequency amplification of your set, you will be able to hear the stations on a loudspeaker.

The tuning of the set is comparatively simple. The only really critical adjustments are those of the aerial circuit and the potentiometer. It is best to experiment first on the local stations. Once the approximate adjustments for local stations are found, the controls near these points will bring in the distant stations.

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Unique Lead-Pencil Holder Prevents Waste Motions

ANY one who constantly uses a lead pencil at a desk or drafting table can save much time by keeping it in a holder made as indicated by boring a slanting hole in a block of wood. The hole should be large enough so that the pencil fits easily and loosely into it and at an angle identical

The pencil is always at an angle ready for writing and no time is lost in picking it up from the desk

with that in which the pencil is used for writing.

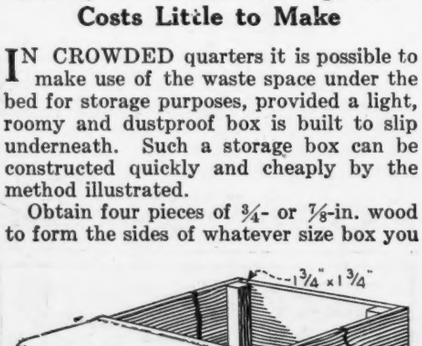
I have found that this is a time-saving "kink" because it enables me to pick up the pencil and write immediately. The method used by most people who write is to lay the lead pencil down on the table so that it must be picked up and moved around until the fingers get it into the usual writing position.

With this holder the pencil is always in the correct position and useless motions are eliminated.—W. F. SCHAPHORST, M.E., Newark, N. J.

Roomy Under-Bed Storage Box Costs Little to Make

IN CROWDED quarters it is possible to make use of the waste space under the bed for storage purposes, provided a light, roomy and dustproof box is built to slip underneath. Such a storage box can be constructed quickly and cheaply by the method illustrated.

Obtain four pieces of ¾- or ⅞-in. wood to form the sides of whatever size box you



This simple storage box, which can be made any convenient size, is covered with an ordinary window shade

wish to construct. Then screw or nail them together at the corners to 1¾-in. square pieces, as shown. Three wooden strips are fastened to the bottom of the frame, one in the center and one at each end, and a wallboard bottom is tacked in place.

An ordinary shade is used for the cover, the roller being fastened to a wooden strip at the rear of the box. Chair casters or, if preferred, cheap, rubber-tired bassinet wheels are provided so that the box will roll easily, no matter how heavy the contents.—C. M.

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Neat Screw Heads Reveal the Skilful Mechanic

AMATEUR mechanics too often overlook one simple but important matter—the appearance of the heads of screws.

It is not always easy to get all screws in without marring them, especially if they are driven hard, and this applies as well to machine as to wood screws, and to nuts and bolt heads. One good plan, when it is necessary to remove and replace screws frequently during construction, is to use an entirely new set of screws for the final assembly.

Incidentally, too little importance usually is attached to the screwdriver. It is an important tool. The mechanic who has any regard for his work or for his tools will always use a screwdriver that fits well in the screw slot, without taper. There is nothing so hard on screws as a driver with a taper-ended blade. Furthermore, such a tool will not transmit maximum power to a screw in a hard drive, for it will slip out. A driver that fits properly will break a screw head before it slips, if it is big enough for the job.

Suggestions for polishing and chamfering screw heads, and an improperly tapered screwdriver

Polished screw heads add much to appearances, and ordinary iron screws can be made to look almost like nickel-plated ones if a little polishing is done. A lathe, though convenient for polishing, is by no means necessary. Just as good a job can be done by putting the screw in the chuck of a drillstock, placing the stock in the vise, and turning the drill while polishing the screw head with fine emery cloth. Short rods can be polished in the same way.

The ends of nuts also can be polished in the drillstock, but the faces are best finished by working them on emery cloth laid on a perfectly flat surface. Better yet, glue the cloth to a piece of wood. When the abrasive becomes worn, make another and keep the old one for finer work.

Oval-headed screws often add much to the appearance of a piece of work and in many cases they are not readily obtained. A flat head can be made into an oval head by the simple process of using a fine file on the head as it rotates in the lathe or drillstock, and finishing with emery cloth.

Another way to obtain a good effect is to bevel the head of a filister-headed screw, using the same process, but working carefully in order to get a clean, sharp bevel. If the screw head is painted or enameled red or black—all except the bevel, which is left bright—the effect is attractive.

THERE is one man who is very careful to take out all the tubes in his radio set before he changes connections. He is the one who has burned out one or more bulbs by accidentally connecting his B battery voltage across the filaments of his tubes. It is good practice to test across the filament terminals of a socket before inserting the tubes, either with a voltmeter or a test lamp consisting of a flashlight lamp, socket, and two flexible leads.

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Convenient Sewing Screen Costs Little for Materials

THE sewing screen illustrated, which was designed by the United States Department of Agriculture, takes up little room, is light in weight, can be carried wherever needed, and is inexpensive to construct. It consists of two panels 13½ in. wide and 28 in. high, hinged together.

The panels are simply frames of 1 by 2 in. wooden strips covered with burlap. A

The sewing screen open, showing the work shelf and equipment

small wooden drop shelf with bracket support is the only other woodwork necessary.

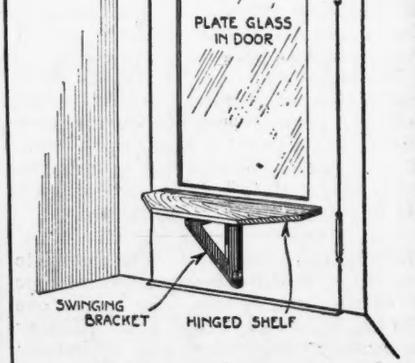
The materials required are:

10 ft. lumber, 1 by 2 in.
Six 1½-in. butt hinges with screws to be used in joining the panels and fastening the drop shelf to the cross pieces
One handle with screws for top of screen
One hook and eye to fasten panels when they are closed and folded
2 yds. burlap, denim, or canvas, 18 in. wide
1 doz. brass cup hooks
1 yd. of cretonne for pockets
1 yd. of ½-in. elastic for top of pockets
4 doz. upholstering tacks for tacking burlap
Sandpaper and stain.

The screen can be equipped with sewing materials to suit the needs of the user.

Shop Door Used for Display

A SHOP door can sometimes be used effectively for special evening window displays. This is accomplished by hingeing a shelf to the back of the door, as shown, and



Special merchandise is placed on the shelf to supplement window displays in the evening

supporting it with a swinging bracket. A powerful light is mounted on the ceiling directly above or on a swinging arm.—M. C.

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Positive Clutch Simply Made for Small Machines and Models

By Howard Greene

IN EXPERIMENTAL mechanics and model work it often is desirable to use a positive clutch for throwing the driving power on or off. The easily built device illustrated answers this purpose well.

While the clutch can be applied in a variety of ways, one example will make the principle clear, so that the experimenter can adapt it to his own work. Assume that the driven shaft of the machine has a projecting end upon which a pulley (or gear) is mounted. The first step is to remove the key, pin, or setscrew and make the bore sufficiently large so that the pulley will run freely on the shaft. It is kept in place by a pinned or setscrewed collar.

A steel pin or a machine screw with a plain shank is inserted in the pulley, as shown. If a machine screw is used, the head is cut off after insertion.

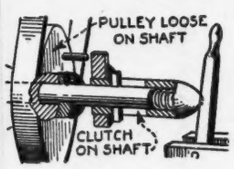


Diagram of the clutch

Drill the shaft, beyond the collar, for a tightly fitting steel pin that will project on both sides, but do not yet drive the pin. Over the end of the shaft fit a piece of heavy tubing that will slide easily, but without much shake. Slot the tube at diametrically opposite points, so that when the tube is in place on the shaft and the pin is driven in, the tube will slide lengthwise, but will be prevented by the pin from rotating in relation to the shaft. For very light work, a single pin and a single slot will suffice.

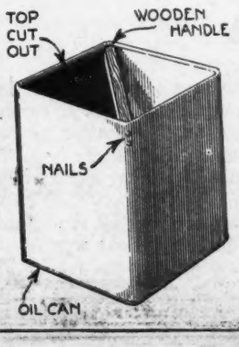
Leave part of the tube projecting beyond the shaft, and plug the end, after inserting a light coiled spring in the space between the plug and the end of the shaft. On the opposite end of the tube, pin a collar with a projecting arm. If the tube is heavy and the work light, a pin screwed into the tube will answer. This is to engage the pulley pin.

If the pulley is driven by a belt, it rotates on the shaft idly, but a push on the end of the sliding tube moves the arm to a point where it is picked up by the pin on the pulley, and the shaft is then driven. When pressure on the tube is released, the spring automatically throws out the clutch.

If something more complete in the way of control is required, a lever can be made as shown. The end of the tube is brought to a rounded point so that it will turn freely against the lever, which should be relatively broad. A regular collar and fork may also be used, but will not work better.

Tin Buckets for the Shop

THERE always seems to be a shortage of buckets around the home garage. Buckets are used for holding drained oil, for washing parts, for holding bolts and screws, and the like. A supply of buckets, however, can be made up readily from empty square oilcans by cutting off the tops and fitting wooden handles as shown at right.—J. E.



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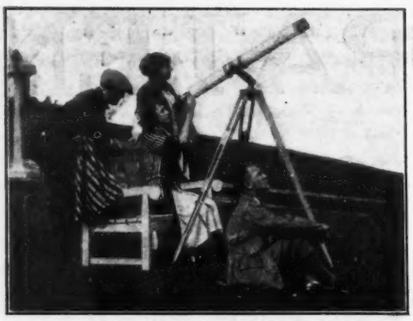

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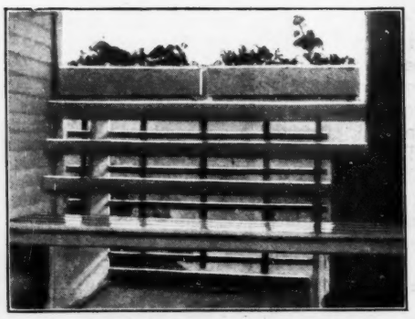
Attractive Built-In Bench Made for a Window Corner

By M. Langsdorf

BUILT-IN benches made by the home worker often add to the beauty and individuality of a home. They fit especially well in a window corner, such as the one illustrated, or on a porch.

The interior bench shown was built in a corner of a small alcove to form a magazine nook and to give added seating room. A simple cut-out scroll is added to break the plain lines, while an inexpensive stock molding above and baseboard below finish the top and bottom. The seats and backs slant to make them more comfortable.

Built on exceedingly simple lines, this window bench costs little and gives added attractiveness to a small room



A unique built-in porch bench that supports flower boxes and a trellis for vines

The boards were cut at the mill the exact size needed, and therefore it was comparatively easy to put the bench together.

Two open sides of the bungalow porch also were beautified by built-in benches, fitted between the columns and the house.

Perforating Blank Forms

A SHEET of wire window screen and a knife or needle are all that are necessary to perforate paper or cardboard forms. The forms are laid on the screen and, if paper, a needle is drawn along a straight edge at the desired place. For heavier cards a sharp knife is used. The angle at which the cutting instrument is held and the mesh of the screen determine the fineness or coarseness of the perforation.

This expedient was found to work well in perforating the return blanks of a large number of shop forms when the regular perforator was not available.—H. E. B.

Stromberg-Carlson Radio Head Sets

are wound a layer at a time, with insulation wrapped between each layer. This is the reason why Stromberg-Carlson Head Sets stand up under high plate voltages.

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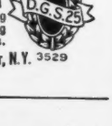

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Home Workshop Chemistry

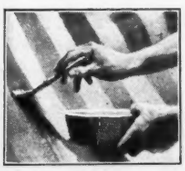
Simple Formulas that Will Save Time and Money

WOODWORK, especially that part of the bench used for soldering, heating glues and the like, can be fireproofed by covering it with a substance that prevents the air from reaching the wood. Waterglass does this effectively when brushed over the wood by precipitating silicic acid in the pores. The wood will then withstand heat and flames for a much longer time than ordinarily.

Fireproofing the workbench top

To diluted waterglass (sodium silicate), precipitated chalk is added and the woodwork is covered with it, or syrupy sodium silicate is brushed on and then covered with a wash of ordinary slaked lime.

A cement that withstands a high degree of heat and also has acid-proofing properties for wood, metal, glass, porcelain, and stoneware, consists of powdered or fine shredded asbestos mixed with waterglass, to which a little barium sulphate is added. For a small job, a teaspoonful of asbestos is mixed with a teaspoonful of waterglass and, when thoroughly worked together, 1½ teaspoons of barium sulphate are added. This thick mixture must be applied quickly and left about half a day to set thoroughly.



Waterproofing a tent

Slight cracks can be filled by a mixture of asbestos and waterglass, the part afterward being washed with a solution of calcium chlorid for a quarter of an hour.

Fabrics such as the canvas of your tent can be waterproofed with a mixture of 4 oz. petrolatum, ½ oz. beeswax, 1¼ gals. gasoline and 1 gal. kerosene. In place of the petrolatum and beeswax, 6 oz. tallow with 2 oz. cod oil can be used. If it settles or thickens, warm the mixture just before brushing it on the canvas. This must be done in the open air by placing the container in a large kettle of boiling water. Be sure that no flames are near or over it and see that the container is open so that the mixture can be stirred.—ERNEST BADE, Ph.D.

Small Slide Rest Tools Used for Hand Turning

SMALL lathe work, such as the amateur machinist does, can sometimes be handled to better advantage with hand tools than by using the slide rest. It is a good deal of trouble, however, to provide a duplicate set of handled tools. To avoid this, simply obtain a common hollow tool handle with a chuck, which will take round or square tools.

Lathe tools and holder

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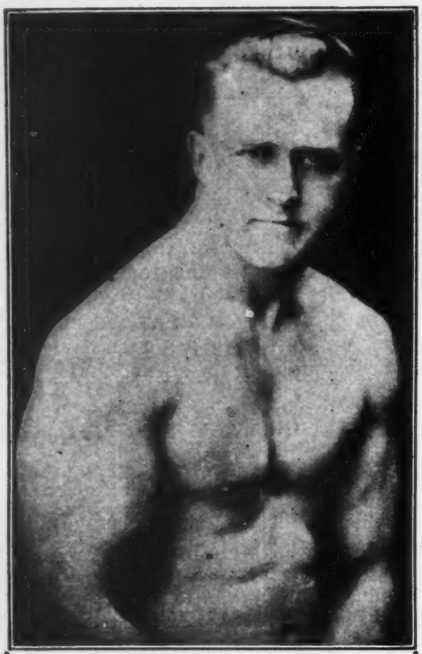

Latest Photograph of Earle E. Liederman

If you were dying tonight and I offered you something that would give you ten years more to live, would you take it? You'd grab it. Well, fellows, I've got it, but don't wait till you're dying or it won't do you a bit of good. It will then be too late. Right now is the time. Tomorrow, or any day some disease will get you and if you have not equipped yourself to fight it off, you're gone. I don't claim to cure disease. I am not a medical doctor, but I'll put you in such condition that the doctor will starve to death waiting for you to take sick. Can you imagine a mosquito trying to bite a brick wall? A fine chance.

A REBUILT MAN

I like to get the weak ones. I delight in getting hold of a man who has been turned down as hopeless by others. It's easy enough to finish a task that's more than half done. But give me the weak, sickly chap and watch him grow stronger. That's what I like. It's fun to me because I know I can do it, and I like to give the other fellow the laugh. I don't just give you a veneer of muscle that looks good to others. I work on you both inside and out. I not only put big, massive arms and legs on you but I build up those inner muscles that surround your vital organs—the kind that give you real pep and energy, the kind that fire you with ambition and the courage to tackle anything set before you.

ALL I ASK IS NINETY DAYS

I'll put one full inch on your arm in just 30 days. Yes, and two full inches on your chest in the same length of time. Meanwhile, I'm putting pep into your old back-bone. And from then on, just watch 'em grow. At the end of thirty days you won't know yourself. Your whole body will take on an entirely different appearance. But you've only started. Now comes the real works. I've only built my foundation. I want just sixty days more (ninety in all) and you'll make those friends of yours that think they're strong look like something the cat dragged in.

A REAL MAN

When I'm through with you, you're a real man. The kind that can prove it. You will be able to do things that you had thought impossible. Your deep full chest breathes in rich pure air stimulating your blood and making you just bubble over with vim and vitality. Your huge, square shoulders and your massive muscular arms have that craving for the exercise of a regular he man. You have the flash to your eye and the pep to your step that will make you admired and sought after in both the business and social world.

This is no idle prattle, fellows. If you doubt me make me prove it. Go ahead. I like it. I have already done this for thousands of others and my records are unchallenged. What I have done for them, I will do for you. Come, then, for time flies and every day counts. Let this very day be the beginning of new life to you. SEND FOR MY BOOK.

"MUSCULAR DEVELOPMENT"

It contains forty-three full-page photographs of myself and some of the many prize-winning pupils I have trained. Some of these came to me as pitiful weaklings, imploring me to help them. Look them over now and you will marvel at their present physiques. The book will prove an impetus and a real inspiration to you. It will thrill you through and through. All I ask is 10 cents to cover the cost of wrapping and mailing and it is yours to keep. This will not obligate you at all, but for the sake of your future health and happiness, do not put it off. Send today—right now, before you turn this page.

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The Shipshape Home

How to Do the Odd Jobs

Sawing Wood

A TEETERING box, an old kitchen chair, or a three-legged stool are poor substitutes for a sawhorse or sawbuck. The experienced mechanic looks around for some solid bearing on which to saw, even if he has to cut only a few pieces. It makes tiring work and is wasteful of time to saw on a poor and uneven support.

Grip the saw handle easily with three fingers and thumb, but let the index finger reach along the saw handle, pointing toward the blade. This gives a much better grip and more accurate control over the saw.

Note the angle at which the carpenter cuts. It is neither too perpendicular nor too slanting. The saw is filed to cut at a correct angle, so find that angle and see how much faster the work goes.

While it is needless to say that the saw cuts only on the downward motion, many amateurs, nevertheless, waste much effort on the up stroke. Learn the easiest way to pull the saw up without friction. Some men put about as much "steam" in the upward motion as in the cutting stroke. This is pure waste of energy. Take a long stroke; short strokes are waste of effort.

Learn to "sight" the saw and keep your eye on the mark at the same time so as to saw straight to the line. If you cannot then saw straight and true, the saw teeth are uneven and need to be properly filed.

If the saw sticks, the work is doubly hard. In that case it may be necessary to have the teeth set by an expert. If you have had no experience in setting and sharpening saws, either have a carpenter show you or refer to the instructions contained on page 108 of the March, 1923, issue of POPULAR SCIENCE MONTHLY. The finer the work, the less set is necessary.

A dull saw, like a dull razor, tears and does not cut. As in the case of all other tools, the time and pains spent in maintaining saws in good condition are well repaid.

(Continued on page 135)

Dollars for Ideas

IN KEEPING your home shipshape, you often hit upon ingenious, time-saving, labor-saving and money-saving ideas.

If you will describe, in not more than 200 words, each of your ingenious keeping - the - home - shipshape methods, we will pay $2 for every one published. Include a pencil sketch or photograph to illustrate the idea, if possible, and address your letter to the Home Workshop Editor, Popular Science Monthly, 225 West 39th Street, New York.

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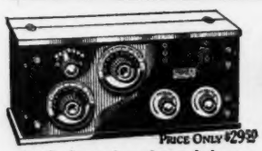

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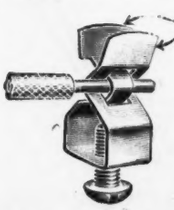

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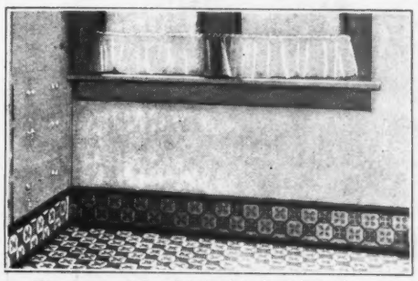
(Continued from page 134)

Linoleum Baseboard

A KITCHEN can sometimes be made more attractive, and at the same time easier to keep clean, by using linoleum in place of or to cover the ordinary wooden baseboard. If the baseboard is old and badly scratched and worn, this is an improvement well worth the cost.

The quarter round molding that is almost invariably used as a finish between the



The ease with which this baseboard can be kept clean and its neat appearance recommend it for the modern kitchen

wooden baseboard and the floor, is removed, as well as the molding along the top edge of the baseboard. The nails are carefully taken out through the back or cut off, not driven through the face of the molding. Strips of linoleum are then cut a trifle wider than the baseboard and tacked or cemented in place. The upper edge is turned over the top of the baseboard and the molding replaced. The lower edge is similarly concealed by nailing the quarter round molding into the corner.

Painting Floors

PAINTING floors is usually considered a disagreeable type of manual labor because of the backaches that almost invariably result when one attempts to do the painting while standing up, or the sore knees caused when one does it while kneeling. The writer has tried both methods and does not like either. Recently, while painting the porch floor, he asked himself, "Why not sit down?"

A simple stool was made, as illustrated, out of a 1-in. board, about 8 in. square, a

The one legged stool

2 by 4, 1 ft. long, and some cloth. The cloth was wrapped around the lower end of the 2 by 4 to protect the floor from scratches.

A one-legged is preferable to a three-legged stool, because it permits considerable movement and enables one to cover a large area of floor before making a move. The weight mainly rests upon the stool and the legs are used only for maintaining the balance and shifting around from place to place.—N. G. NEAR.

A pipe-smoker's challenge to other smokers

Is there a smoker in the audience who can answer this one

Nearly every smoker is particular about the kind of tobacco that goes into his pipe. While he may smoke a pipeful from a friend's pouch for the sake of companionship, for day-in and day-out smoking he prefers his own brand.

And yet if you ask the average smoker what it is he likes about his tobacco, he may have difficulty in answering you.

Mr. Joe Rivers, whose letter follows, is a confirmed Edgeworth smoker. In attempting to describe what he likes about Edgeworth, he coins the word "tasty-smellfulness." But as this does not entirely satisfy him, he puts the question up to other Edgeworth smokers.

Larus & Brother Company, Richmond, Va.
Gentlemen:

Being a pipe smoker of no mean experience (having tried most pipes and pipe tobaccos) I've watched your smokers' letters in the magazines for some explanation of a taste that for me applies only to Edgeworth.

It is extremely difficult to describe this, because it seems to come as the smoke filters through the mouth and nostrils at the end of a draw from the pipe—a sort of combined "tasty-smellfulness" that most satisfies the smoke appetite.

Why don't you get some of your smokers who can write, to describe this.

Sincerely yours,
(Signed) Joe Rivers.

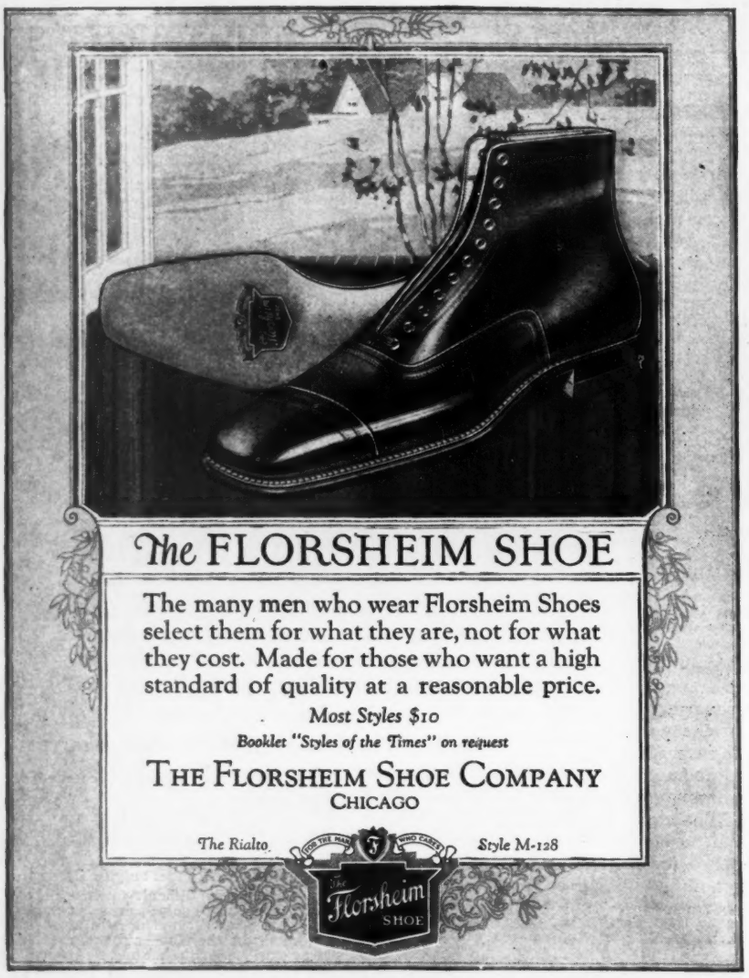
Probably there are any number of reasons why men smoke Edgeworth. One friend actually admitted he smoked it because his wife liked the shape of the Edgeworth glass jars to fit on her pantry shelf.

However, the one outstanding feature of Edgeworth, as seen by most smokers, is its uniformity. Year after year smokers can be sure of getting the same high-grade quality of tobacco.

If you have not tried Edgeworth, send your name and address to Larus & Brother Company, 59 South 21st Street, Richmond, Va. They will be glad to mail to you some free samples, generous helpings of both Edgeworth Plug Slice and Ready-Rubbed.

If you will also include the name and address of your regular tobacco dealer, your courtesy will be appreciated.

To Retail Tobacco Merchants: If your jobber cannot supply you with Edgeworth, Larus & Brother Company will gladly send you prepaid by parcel post a one- or two-dozen carton of any size of Edgeworth Plug slice or Ready-Rubbed for the same price you would pay the jobber.



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The many men who wear Florsheim Shoes select them for what they are, not for what they cost. Made for those who want a high standard of quality at a reasonable price.

Most Styles $10

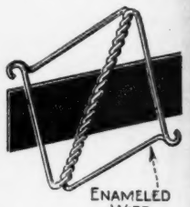
Booklet "Styles of the Times" on request

THE FLORSHEIM SHOE COMPANY
CHICAGO

The Rialto *Style M-128*

Small Radio Condensers Made from Enameled Wire

WITH nothing more than two enameled wires, a fixed condenser for radio receiving of practically any ordinarily required capacity can be made within two or three minutes' time. The wire can be any gage from 14 to 24. Two short lengths are twisted together and connected as illustrated. How much wire to be used can be found quickly by trial.

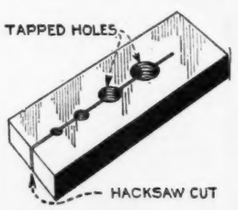


A cheap condenser

The enameled insulation has a high dielectric strength and consequently a condenser of high capacity is formed by twisting the wires in this way. Two lengths 6 in. long are sufficient for making a fixed condenser that is generally useful in the average experimental radio set.

Cutting Off Machine Screws

THE amateur machinist is constantly cutting off small machine screws to suit the work in hand. Time can be saved in doing this if a small clamp, made as shown, is used. It is simply a piece of cold rolled steel drilled, tapped, and split with a hacksaw.



The screw-holding plate

To use this fixture, put the screw to be cut into the proper hole and place the clamp between the jaws of the vise. The screw then can be cut with a hacksaw or file and the end chamfered ready for use. The clamp also can be used as a gage for cutting a number of screws to the same length.—H. G.

Model Airplane Propeller

IN MAKING toy airplanes, air driven hydrosleds, and similar models, the home worker is often puzzled as to the best way to make a strong, good-looking propeller. Frequently these are carved out of the solid, but it is really easier and more effective to make them laminated.

Laminated construction simplifies carving the propeller

If possible, use alternate layers of whitewood or pine and walnut or mahogany. For a propeller ¾ in. thick, use five plies; in any case, use an odd number so that the mahogany or walnut can be placed on the outside.

Cut and plane the pieces alike, drill them in the center, and then spread them apart fan shape, as shown. Spring each piece out sufficiently to run hot glue between them and clamp them together until the glue hardens. Carving the propeller then becomes a simple matter.—E. C. J.

ONE CHARGER
for Every Radio Battery

—And, in fact, *the only one* which you need. Keeps strong clear signals in your set by keeping the batteries to full capacity.

The Valley Type ABC Battery Charger is made for all storage batteries—2-volt peanut tube batteries, 6-volt A Batteries and 1 to 4 B Batteries. Bakelite panel, glass top—belongs to a radio receiving set.

Frankly, production is limited. Late buyers are going to be disappointed. A lot were last year. Ask to see the Valley Type ABC Charger at any good radio shop.

VALLEY ELECTRIC CO.
3157 S. Kingshighway St. Louis, Mo.

Valley Battery Charger

Adjusto-Lite
A FARBERWARE PRODUCT
(Reg. U. S. Pat. Off.)

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Prices in U. S. & Canada, brass $5; bronze, nickel, or white enamel finish, $5.50. West of Mississippi River, 25c higher.

Craftwork Novelties Made from a "Two by Four"

By H. S. Trecartin

MANY useful and decorative novelties can be made by the home craftsman from blocks cut from a selected white pine "two by four." I recently fashioned a number of articles from a short length of this wood at a negligible cost. Two of the pieces, a clock stand and a photograph frame, are illustrated.

A small clock stand

The dressed 2 by 4 in. stock actually measures about 1⅞ by 3¾ in. This is large enough to provide a suitable base for small picture frames, calendar stands, desk furnishings, and the like, and at the same time is not too heavy to be easily roughed out with handsaws.

The parallel and square faces give fixed starting points and smooth surfaces upon which the lines may be laid out directly. The rough shape can be cut with backsaw, rip and crosscut saws, brace and bit, chisel, drawknife and plane, before the work is separated from the main body of the two by four. It can thus be held firmly in the vise or secured to the bench while working.

An ornamental photograph frame

Designs and their treatment are unlimited. The pieces may be finished with mechanical accuracy and exact parallelism or cut more or less freehand with chisel, gouge, and knife; the tool marks may be left frankly visible or smoothed away with sandpaper.

Orange shellac gives a rich and lustrous finish, but the pieces can be stained, if preferred, or enameled. An excellent way of finishing is to give a priming coat of ordinary oil paint, rub it down with fine sandpaper to a perfectly smooth surface, and apply decorations with artist's oil colors. An unlimited variety of effects thus can be obtained.

There are so many applications for this common 2 by 4 in. stock in cut-from-the-solid effects that any home worker will be well repaid in spending some of his spare time in developing original ideas for its use.

FEATURES FOR DECEMBER

How to make—

A miniature tea wagon, game table, a garage, kitchen quoits, and other toys.

A realistic electric-lighted model theater.

A table lamp with art glass shade.

A butterfly wing table.

A pair of ski.

And the usual variety of workshop, "Shipshape Home," radio, and auto articles.

You needn't know a thing about radio

NIGHT after night, year after year, a Tuska Radio will bring fine entertainment into your home, at a trifling expense for operating.

You need not depend upon good-natured friends with radio experience to help put a Tuska in your home. Surprise them all by doing it yourself. It is easy to install your own "listening post" and pick up your choice of the wonderful concerts that fill the air.

At pleasure you can tune out any program and tune in another more to your liking. The same Tuska that fills your rooms with clear, unmarred music and distinct speeches will also pick up broadcasting from stations 2000 or more miles away.

Some of the most experienced radio inventors and engineers in this country designed and built the Tuska. It is right, forever, and needs no tinkering. Have no fear that it will soon become obsolete. A Tuska set bought to-day will be serviceable for years to come.

THE C. D. TUSKA CO.
Hartford, Conn.

Tuska Popular No. 225

3-bulb Regenerative Receiving Set. Piano finish mahogany cabinet. Amplifier switch. Concealed binding posts. Armstrong circuit, licensed under Patent No. 1,113,149. Price $75, without bulbs, batteries or loud speaker.

Ask for special circular No. 19-C, describing this set.

The Thrill of Great Distance

For 12 years, Tuska-built radio receivers have been famous for long range reception, and have made records that are unsurpassed.

F. R. Alger, of Prince Albert, Saskatchewan, Canada, says: "I am sending a list of 67 stations, a total distance of 78,200 miles away. You will realize that all stations are far removed from us; most of them have to come over 1000 miles. The Tuska is remarkable for simplicity of tuning. It has been a source of great satisfaction."

TUSKA TRADE MARK REGISTERED RADIO

TUSKA RADIO

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Low Gear Seldom Used
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Ford	34 mi.	Reo	24 mi.	Chevrolet	32 mi.
Buick 4	30 mi.	Chalmers	23 mi.	Maxwl(25)	30 mi.
Buick 6	24 mi.	Olds. 6	23 mi.	Nash 6	23 mi.
Hudson	20 mi.	Paige 6	20 mi.	Lincoln 8	17 mi.
Hupp	25 mi.	Oakland 6	24 mi.	StdbkrLt 6	23 mi.
Dodge	28 mi.	Overl'd 4	32 mi.	Cole 8	17 mi.

If your car is not mentioned here send name and model for particulars and our guarantee on it. AGENTS WANTED.

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You can drive any car in heaviest traffic without shifting gears. Starts off on high in any weather without priming or heating—no jerking or choking. No more foul spark plugs or carbon in cylinders. No leaking of gas into crank case. Try it 30 days on our guarantee of money back if not entirely satisfied. **No strings to our guarantee. YOU ARE THE JUDGE.** Anyone who can handle a wrench can attach it. No boring of new holes or changing of operating mechanism. Write today.

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"I start to-morrow, Mary, at an increase of $60 a month. It's wonderful how spare-time study helps a man to get ahead."

FOR thirty-one years, the I. C. S. has been helping men to win promotion, to earn more money, to get ahead in business and in life.

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Standard Music Co.
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The Ten Greatest Scientists

(*Continued from page 31*)

mystery. If people had any conception at all of what it was like, they thought it was a fluid flowing along wires, somewhat as water flows within a river's banks. Faraday was the first to understand it.

He made the remarkable discovery that electricity could be induced in a wire that lay near another wire in which a current of electricity was flowing. Thus he paved the way for a myriad of inventions. In his careful researches he got a glimpse of the idea that chemical energy could be turned into electricity. All honor must be given to Faraday.

Harvey had made the various organs of the body familiar objects of study. After him came other scientists who described the tissues and the cells. Then came a man whom I put eighth on my list, who investigated the changes in living matter and explained the chemical processes within the human body. This was Claude Bernard.

He, again, was one who looked beyond the obvious. Physicians were saying: "The liver makes bile; therefore the function of the liver is to make bile." But Bernard, conducting experiments on living animals, discovered an internal secretion in the liver that enabled it to store up sugar and serve it out to the blood as the body required it. This discovery at once enabled physicians to understand the disease of diabetes, which before had been incomprehensible.

Bernard Explains Metabolism

Bernard was the first to prove that in the living body continual building up and tearing down processes are in progress. He showed, step by step, how food is taken in, how it is made into living material, and how that material gradually is broken down again. Later, names were given to these processes which we know now as anabolism and catabolism. Because the names came so much later than the discovery, most persons fail to give Bernard the credit for the discovery.

But the most important reason for including Bernard among the greatest scientists is his discovery of the function of the ductless glands—endocrines. In his experiments Bernard observed that the two little red patches near the Adam's apple had something to do with the growth and development of the body. He learned that failure of these ductless glands to do their part retarded not only the physical development, but the mental development of a human being.

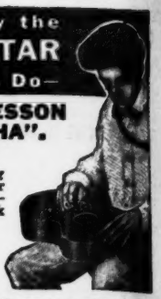
He discovered also that often if persons with symptoms of non-functioning ductless glands were fed or had injected extract of the thyroid glands of sheep, they could be changed from caricatures of humanity, with neck swellings or goiters, into healthy, happy individuals. The man who could make such a marvelous discovery—one that meant a miraculous change in the lives of thousands—certainly should be included among the great.

And now we come to Darwin. "Oh, yes," you may say, "he was the man who said our grandfathers were monkeys." It is too bad that Darwin's work has been understood so little. The present unfortunate trend of aversion to Darwin's teachings in America, I feel, can be due only to misunderstanding.

Darwin did not discover the fact of evolu-

(*Continued on page 139*)

You, Too, Can Play the HAWAIIAN GUITAR Just as the Natives Do—



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Our method is so simple, interesting and appealing that you begin in your first lesson to learn the famous Hawaiian Folk Song "ALOHA". Think how happy you will be when you surprise your friends by playing the fascinating Hawaiian Guitar *just as the natives do!*

Only Four Motions—and You Master Them Quickly!

In a few minutes you acquire the four motions necessary to play one piece—after that a short period of practice and you will have mastered this weirdly sweet music. Complete course of 52 lessons includes FREE beautiful Hawaiian Guitar, necessary picks, steel bar, etc. No extras.

No Previous Musical Knowledge Necessary

If you *never read a musical note in your life*—if you haven't even the slightest knowledge of music, we can quickly and positively teach you to play this wonderfully popular instrument. Don't be just a "listener" when you can *easily be the center of interest* among your friends.

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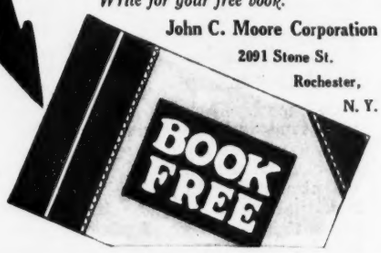

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BLUE WHITE **Luxite DIAMOND**

IF YOU CAN TELL IT FROM A DIAMOND SEND IT BACK!

GENTS' 1 CARAT RINGS $3.97

You'd gladly pay $150 for a genuine Diamond as perfect as this dazzling blue-white Luxite Diamond. Only expert can tell the difference. Full 1 Carat size, only $3.97. while this sale lasts; set in 14K GOLD S. ruar., hand engraved, heavy tooth ring. **DON'T SEND A PENNY!** Simply send name, address and paper strip which fits and to end around finger. Deposit only $3.97 with postman when ring is delivered **we pay postage.** Money back if you're not delighted. If you send today we'll include **FREE** a pair of gold fin, engraved cuff-links, full size, high grade quality.

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Garfield Importing Co., Dept. 380, 3839 Roosevelt Rd., Chicago

The Ten Greatest Scientists

(*Continued from page 138*)

tion. That had been done long before him. But he was the first to make the idea popular, to convince people that there was truth in it. He revised the conception of a static world, a nature standing still. Once, when a man looked at a red beech tree in his garden, he thought that tree came from a red beech tree seed and that all of its ancestors had been red beech trees. But Darwin showed how one day, long ago, the red beech had been an ordinary beech and how it had changed in the centuries until its leaves became red.

Darwin is the one man among those I have chosen for my list of 10 who made no great original discovery, but who worked out thoughts that already had been spoken. He was a methodical, patient man who sought to find out the truth or falsehood of what he heard. His infinite patience was demonstrated when he spent 20 years in writing a single book.

It was his cruise on the ship, the *Beagle*, that started Darwin toward the conviction that nothing lives or dies to itself, that life is a great quivering spider web of which, when one part is touched, the whole is set in motion. On that trip, which he took immediately after he left college, Darwin stopped in South America. There he saw fossils of armadillos. In the same localities where these fossils were found, he saw live armadillos. "Why are the live armadillos found in the same regions with the armadillo fossils?" he asked himself. And the answer came, "Why, these fossils were the ancestors of the living animals," and then he examined the differences between them.

Charles Darwin never threw forth broad generalities and asked people to believe them because he said they were true. He examined everything cautiously, observed closely and long, made painstaking experiments, and *proved* his statements.

Darwin popularized the idea that animals could be changed through breeding. Chicken fanciers and all stock breeders owe much to him, although they seldom acknowledge it.

How Darwin Benefitted Man

The practical benefits that have come from Darwin's teachings are almost endless. One example is the marquis wheat in America that meant so much in the world war. That was the product of evolution, of a conscious effort on the part of those who used the knowledge that Darwin spread to produce wheat of heavy yield.

As great a contribution as the intellectual and practical ones that Darwin made to the world, was an ethical one. Until Darwin's time the "Descent of Man" was the prevailing doctrine. Everywhere people believed that once upon a time man was perfect or nearly so. Adam and Eve in the Garden of Eden went to the bad, and ever since things had been getting steadily worse. Through hard work man had succeeded in clinging to some of his former virtues, but on the whole, it was a hopeless business.

Into this darkness Darwin brought new hope, for his teaching was the "Ascent of Man." He showed that man was growing better, that he had evolved from lower forms, and, therefore, there was the happy prospect of improvement in the future. Darwin, indeed, opened a gate and let in a flood of light.

(*Turn to page 140*)

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The Ten Greatest Scientists

(*Continued from page 139*)

There is only one place left on the all-too-short list and there are many names that I want to place there. But Pasteur overshadows the others and I place him tenth.

The key words to Pasteur are "the biological control of life." He showed that man could conquer the enemies that were oppressing him. No longer need physicians stand helplessly by while fever and pestilence ravaged the land. Pasteur discovered that diseases were due to organisms and he prepared weapons with which to fight them.

His discovery that microbes, as he called them, were responsible for fermentation in beer and wines, led Pasteur to use antiseptic and aseptic methods in his experiments on animals. Later, Joseph Lister applied this principle to man and created modern surgery. Pasteur's discoveries of the cause and methods of treating anthrax and hydrophobia with vaccination and inoculation are famous. Cholera, rabies, diphtheria, all of these scourges, were met on the field of battle by Pasteur, who built up a protective armor against them.

He changed the whole theory of disease and was responsible for the serum treatment so common today. The typhus injection during the World War, which without doubt saved tens of thousands of our soldiers, can be traced directly to Pasteur. Who would deny him a place among the greatest?

THESE, then, are the 10 scientists whom I consider the greatest of the great—Aristotle, Galileo, Newton, Harvey, Lavoisier, Helmholtz, Faraday, Bernard, Darwin, and Pasteur. It will be observed, perhaps, that four Englishmen are included, while there are no Americans. The difference in the characteristics of the two nationalities, I think, explains this. The Englishman is patient, questioning, cautious, willing to spend years, if necessary, trying one experiment after another in the search for the reason for things. The American is more practically minded. He is in a hurry and wants immediate results. That is why there are many famous inventors in America today, men who are rapidly applying the principles discovered by the great scientists.

Why Women Are Not Included

Another noticeable feature about the list is that it contains the name of no woman. This is not because there have been no women in history who have possessed scientific minds. That is far from the truth. It is, I believe, because surrounding circumstances in the past have been such as to hamper rather than encourage any woman inclined to do scientific work.

If I had not restricted myself to the past in searching for the great, the name of Madame Curie with her part in the discovery of radio-activity undoubtedly would have been prominent. But I have not attempted to judge the work of the living, feeling that any judgment that I could make on the basis of only a few years of observation, would be neither fair nor accurate. Two hundred years from now, when some poor man is attempting to choose from all the pages of history those scientists whose names shine the brightest, the name of some one of our contemporaries then may out-dazzle all others.

What I Learned About Old Age

By Byram C. Kelley, A. M., L.L.D.

CERTAIN new facts about old age, recently disclosed to me, constitute the most startling information I have ever received. I am 40 years old myself. I had begun to wonder if I would soon begin to "break"—to lose my old-time pep and aggressiveness, my stamina and resistance to disease. I wondered if I would soon be subject to the class of ailments which seems so prevalent among men past 40. Then through a mutual friend, I made the acquaintance of a member of the American Association for the Advancement of Science, who has recently brought to light most interesting facts about the peculiar conditions common to men past middle age.

Why Many Men Are Old at 40

I had often wondered why so many men begin to lose their vigor and alertness when they are scarcely out of their 30's—yet others, at 60 and 70, seem to be in the prime of life. There must be some reason for this difference. And I found out exactly what this reason is.

65% Have Gland Trouble

I have learned that 65% of all men past a certain middle age have a disorder of a little gland, called the prostate. And prostate disorder is not only the direct cause of much distress, often necessitating operation, but it displays itself in many parts of the body, mental as well as physical.

Common Middle Age Ailments

Here is an important cause for many ailments which heretofore have been simply taken for granted as "old age" symptoms—sciatica, aches in back, legs and feet, frequent nightly risings, nervousness and irritability and frequent dizzy spells indicating high blood pressure; and I learned how, by an astonishingly simple new method that these disorders would be eliminated in many instances in a short time, without drugs or operation—a treatment that reaches this gland directly—yet is so convenient that any one can apply it in their own home.

10,000 Men Find Relief

73 Years Young

But most surprising of all, I find that 10,000 men have already found relief. Statesmen, bankers, lawyers, doctors, in every section of the country are using and endorsing the method. I read many letters. One that was from a man in Colorado. "73 years young is my age," he wrote, "yet for years I suffered with prostate trouble. Used medicine to no avail—had about given up hope when a doctor recommended your treatment." Just think of a man 73 years old being restored to the health and buoyancy of youth. And it is within the reach of every one. There are no drugs, no books, no electric rays.

All Explained in FREE Book

If you are troubled with any of the disorders mentioned, if you have chronic constipation or prostate trouble, you should send for a vitally interesting free book, written by this scientist, called "Why Many Men Are Old at 40." It describes this splendid treatment and shows how you may regain much of your youthful vigor and be free from certain disorders. No obligation. But write at once—the edition is limited. Simply mail request to **The Electro Thermal Company, 4027 Main Street, Steubenville, Ohio,** the concern that is distributing these books for the author.

Conquests of Metal and Coal

(*Continued from page 48*)

In early times, even in the days of the greatness of Egypt and of Rome, there was no steam power. All power came from slaves. The bulk of the Pyramids and the great stones of the Coliseum were raised by the muscles of men. Oxen and horses helped a little, but not much. It remained for the men of the last 300 years to save their own labor and do all this work with coal.

It began a little earlier than that, with a monk who went off to pick blackberries one day in the summer of the year 657. Near the monastery of Glastonbury, in England, where this blackberrying monk happened to live, there was an old and long abandoned stone quarry. Many blackberry vines grew there and that was where the monk went In the course of his day's adventures he chanced across a piece of curious black stone which he took with him to the monastery to show it to the prior.

Now the prior had no desire to be bothered with strange stones picked up by foolish monks in blackberry patches. He threw the black stone impatiently into the fire.

Then came the astonishment. The stone caught fire and burned. The prior, to do him justice, could see a fact when it was simple enough. He quietly bought the quarry, and the "black stones" replaced wood as the monastery fuel. The secret was kept, they say, for over a hundred years. Only this one house in all the world was heated by coal.

Coal Becomes a Common Fuel

But in the end, of course, the secret leaked out. Coal began to be used for fuel all over England. One by one, beds of it were discovered elsewhere in the world, and it became a common fuel among the well to do.

Every one is familiar with the rest of the story. The power of steam had been known to many ancient scientists. An Egyptian temple, for example, had possessed an apparatus that opened the doors of the shrine when a fire was built on the altar so that it heated a steam chamber placed beneath. Hero, the great experimenter of Alexandria, had built a kind of revolving engine propelled by escaping jets of steam.

But all this had been forgotten. Steam was rediscovered by James Watt and his teakettle. It was applied in Cornwall to drive the pumping engines that lifted water out of the tin mines. Step by step, the use of the new power was extended and improved, multiplying by scores and then by hundreds of times the work that can be done by a single man.

With the perfection of this use of steam we arrive at present times—at the Age of Coal and Iron that was promised when man found his first gold bead in the streams; that came nearer with the discovery of copper tools; that reached its latest turning point when the monk of Glastonbury brought home the first lump of coal.

Later developments of the use of power, such as the gasoline engine and electricity, do not belong in this story. They are, of course, part of the evolution of the world, of man's growing control of it. But they were inevitable once man had made the great discovery of metals and the still greater discovery that he could secure from

(*Turn to page 142*)

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Conquests of Metal and Coal

(*Continued from page 141*)

coal or elsewhere vast resources of mechanical power so that he himself would not have to work so hard.

We come back, then, to the thought with which I began this chapter. Materials and power, iron (which is our most necessary material), and coal, are the things that make possible the present life of the world. They multiply the power of man. One man, on the average, can produce more food or distribute more food than one man could ever do in the previous history of the world. And so there *is* more food. More people can live in the world, and can live, on the whole, more happily. Material civilization, to us who have come so recently from a war, may not seem an unmixed blessing. But when one strikes a balance between the bad things it has done to us and the good things, the result, I think, is good. The world is not perfect, but it is better off than it ever was before.

And this, when one stops to think it out, is about all that evolution means.

Evolution Leads Us Onward

But evolution, as I have said, keeps on. If the world on the whole is not now so badly off, have we a chance that it may be still better? The evolutionist's answer is an emphatic yes.

There are vast sources of useful power that are still untapped—water power, the power of the tides, power from the inside of atoms. Perhaps there are materials, too, that wait to be discovered—new metals or alloys, cheaper and better building materials, improved substances for tools, none of which we dream of now, any more than the savage who found the first copper in the ashes of his fire dreamed how far that find of his would lead the world.

The progress of discovery did not stop with the sifting of those ashes. There is no reason to think that it will stop now.

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